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FINAL REPORT

TUMWATER FALLS AND DRYDEN DAM
FISH PASSAGE PROJECT

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MAY 1984

FINAL REPORT

PRELIMINARY ENGINEERING DESIGN

TUMWATER FALLS AND DRYDEN DAM
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CHAPTER 1
SUMMARY AND CONCLUSIONS

SUMMARY OF FINDINGS

Tumwater Falls and Dryden dams, both on the Wenatchee River in Central Washington, were built in the early 1900's as diversions for hydropower, and irrigation and hydropower, respectively. In recent years, the hydropower generation at both sites has been abandoned. Tumwater Falls Dam is maintained only for its aesthetic value and potential for hydropower. Dryden Dam is maintained as a diversion for irrigation flow and for its hydropower potential. The present fishway facilities at both sites are inadequate to properly pass the anadromous fish runs in the Wenatchee River. These runs include spring and summer chinook salmon, sockeye salmon, coho salmon and steelhead trout.

Predesign level drawings are provided in this report which represent f ishuay schemes capable of adequately passing present and projected fish runs. At the Tumwater Falls site this involves a single vertical slotted ladder with 19 pools, nominally 12 ft wide by 8 ft long. The total capital cost of this facility, including construction and engineering, in FY 1985 funds is estimated to be $933,000. Proposed facilities at Dryden Dam include vertical slotted ladders at the west bank (6 pools, nominally 8 ft wide by 10 ft long) and at the east bank (10 pools nominally 8 ft wide by 10 ft long). The total capital cost of these facilities, including construction and engineering, in FY 1985 funds is estimated to be $946,000.

The effects of present passage facilities on anadromous fish stocks are addressed both quantitatively and qualitatively in this report. The quantitative treatment estimates losses of adult migrants due to the structures and places an economic value on those fish. The dollar figure is estimated to be between $391,000 and $701,000 annually for both structures. The qualitative approach to benefits deals with the concept of stock vigor, the need for passage improvements to help ensure the health of the anadromous fish stocks of the Wenatchee River.

A Benefit/Cost analysis was performed to determine the B/C ratios for the range of economic benefits. This analysis yielded B/C ratios of 4.1 and 7.3 for the "low" and "high" estimates of benefits, respectively.

CONCLUSIONS AND RECOMMENDATIONS

This study indicates that there is a clear need for the proposed improvements. The economic analysis shows that the investment is strongly justified according to the standards governing such projects. The anticipated benefits to the Wenatchee Basin and Columbia River fisheries will far exceed the total estimated costs of the project. Ott Water Engineers, Inc. recommends that the Bonneville Power Administration take the necessary steps toward final design and construction.

CHAPTER 2
INTRODUCTION

PURPOSE OF PROJECT

The Tumwater Falls and Dryden Dam Fish Passage Project is included in the Northwest Power Planning Council's Columbia River Basin Fish and Wildlife Program Section 604(c)(3), (1982). The purpose of this project is to improve upstream passage for adult anadromous fish. This first phase evaluates feasibility of fish passage improvements for both dams.

AUTHORITY

The Northwest Power Planning Council's Fish and Wildlife Program states that Bonneville Power Administration shall fund feasibility studies to correct fish passage problems at Tumwater Falls and Dryden Dam. To satisfy this measure, BPA contracted with Ott Water Engineers, Inc. on July 27, 1983 to conduct a feasibility study for improvement of adult fish passage facilities at Tumwater Falls and Dryden Dam. This report has been prepared as partial fulfillment of OTT's contract with BPA.

SCOPE OF STUDY

The scope of this study had four objectives as follows:

- Select a method for improving anadromous fish passage around both the Dryden and Tumwater facilities that will have the greatest probability of complete long-term success.

- Analyze the project through a projection of expected benefits.

- Expedite the review and authorization process for implementation.

- Perform necessary environmental analysis to meet state and federal requirements.

The four objectives were accomplished through eight tasks. These tasks were:

1. Field Investigation
2. Formulation of Alternatives
3. Agency Coordination
4. Analysis of Benefits
5. Evaluation of Alternatives
6. Plan Selection and Predesign
7. Preliminary Environmental Review
8. Institutional Arrangements

SUBCONTRACTORS

OTT subcontracted with five consultants during the Tumwater Falls and Dryden Dams project: Milo C. Bell, James W. Buell Ph.D., Kim de Rubertis, Robert L. Rulifson and John F. Orsborn Ph.D. Mr. Bell, a fish facilities engineer, lead the alternative formulation and selection tasks. Dr. Buell, a fish biologist, conducted the benefits task as well as participating in agency coordination and environmental assessment. Mr. de Rubertis, a geotechnical engineer, performed the preliminary geotechnical and geological investigation. Mr. Rulifson, a fish biologist, participated in the environmental assessment task. Dr. Orsborn reviewed the predesigns.

CHAPTER 3
SITE CHARACTERISTICS AND EXISTING FACILITIES

GENERAL

The Tumwater Falls and Dryden Dam project involves two sites on the Wenatchee River in Central Washington. As shown in Figure 1, Tumwater Falls is approximately 24 miles northwest of the City of Wenatchee, Washington and Dryden Dam is approximately 14 miles northwest of the City of Wenatchee.

TUMWATER FALLS

Tumwater Falls Dam has 400 ft of crest length at elevation 1487 ft with approximately 20 ft of head. The dam cross-section is a concrete ogee with a timber crib/concrete foundation and operates as an uncontrolled spillway. Figure 2 shows Tumwater Falls Dam in plan, and the topography of the immediate area. Figures 3 and 4 are photographs of the site; Figure 3 is taken from the left bank looking downstream and Figure 4 is taken from the left bank looking across the structure. (Throughout this report the right and left banks are referred to looking downstream.)

As seen in Figure 3, the left bank of Tumwater Falls has a weir and pool fishway; adjacent to the fishway is an unused caretaker residence. The right bank is occupied by a log sluice and intake structure (the diversion point for the power plant that was located 2.2 miles downstream). The intake area, as well as the upstream side of the ogee, is heavily laden with sediment (Chelan County PUD 1980b). The toe of the ogee structure is protected by a sloping concrete apron, shown in Figure 4.

DRYDEN

Dryden Dam operates as an uncontrolled spillway with approximately 1000 ft of crest length and a crest elevation of 969 ft. As shown in Figure 5, there are two distinct types of construction at Dryden Dam. The section parallel to the flow is a low concrete buttress weir about 3 ft in height and approximately 500 ft in length. The dam sections roughly normal to the flow are timber crib construction. Figure 6 is a photograph of the upstream timber crib section taken from the right bank looking across the stream. Figure 7 is a photograph taken from the right bank looking across the river which shows the concrete weir and downstream sections of timber crib.

The principal features of the Dryden site, apart from the weir, are: trash sluices, a weir and pool fishway, gate house, log boom and canal. The existing fishway is on the right bank adjacent to the trash sluice. The canal intake, gate house, log boom and second trash sluice are at the left bank. The canal cross-section is trapezoidal with flow regulated by three steel sluice gates covered by the gate house. The capacity of the canal is estimated to be 500 cubic feet per second (cfs) (Chelan County PUD 1980a); it has degraded from its original capacity of 1300 cfs. The canal length is approximately one mile, extending to the old powerhouse site and irrigation diversion.

HISTORY AND OWNERSHIP

TUMWATER FALLS

Tumwater Falls Dam was built in 1909 by the Great Northern Railroad Company as part of a hydropower production facility. Electricity generated was used to power Great Northern's railway trolley over the Cascade Mountains between Wenatchee and Skykomish. To develop 6 megawatts of power, up to 1400 cfs were

diverted more than 2 miles downstream producing about 200 ft of gross head (Chelan County PUD 1980b).

Between the years of 1924 and 1957, Puget Sound Power and Light Company leased and operated Tumwater Falls Dam. After Great Northern abondoned the electric railway for diesel locomotives in 1957, Chelan County PUD purchased the dam from Great Northern; power production ceased shortly before this due to destruction of a portion of the penstock by a rockslide.

In 1978, Chelan County PUD initiated redevelopment of the Tumwater Falls project. After receiving a Preliminary Permit and conducting initial investigations, Chelan County PUD discontinued redevelopment efforts in 1981 since the project was, in their estimate, not economically feasible at the time. Since Chelan County PUD's surrender of the Preliminary Permit, competing permits have been filed on the site by T. Forbes of Hydro Energy Associates and the City of Sultan, Washington. At the writing of this report, no Preliminary Permit has been issued.

DRYDEN

Dryden Dam was built in 1907 to divert irrigation water into the canal then known as the Highline Irrigation Canal. Hydroelectric facilities were added in 1908. Between 1907 and 1924 the Dryden project was operated by a number of concerns. From 1924 to 1948, Puget Sound Power and Light Company owned and operated Dryden Dam; after which, it was owned and operated by Chelan County PUD. Power production was terminated December 31, 1957 when it was determined that operation and maintenance costs outweighed benefits.

Chelan County PUD considered redevelopment of Dryden Dam for hydropower between 1962 and 1965, and again between 1978 and 1981; both redevelopment efforts were abandoned as not being cost

effective at the time. After Chelan County PUD's surrender of the Dryden Preliminary Permit in 1981, T. Forbes of Dryden Associates filed for a Preliminary Permit on the site. This Preliminary Permit was issued in 1983.

EXISTING FACILITIES USE

TUMWATER FALLS

Although Tumwater Falls Dam is not used for hydropower production, it has potential for future development. Residents of the City of Leavenworth also consider Tumwater Falls an aesthetic asset, as do residents living near the impoundment Lake Jolanda (pers. comm., Roger Purdom).

DRYDEN

Like Tumwater Falls, Dryden Dam is no longer used for hydropower production, however, the potential for future development does exist. Dryden Dam also serves as a diversion for irrigation flow for the Wenatchee Reclamation District (WRD). As owner of the site, Chelan County PUD is obligated to supply 200 cfs through the canal to the WRD.

CHAPTER 4
GEOTECHNICAL ASPECTS

The purpose of this chapter is to describe the geotechnical aspects of the sites as they relate to regional and site geology, and design and construction considerations. This particular phase of the study was undertaken after preparation of predesign layouts at each site.

TUMWATER FALLS

REGIONAL AND SITE GEOLOGY

The rocks of the Mt. Stuart Batholith dominate the geology of Tumwater Canyon in which the project is situated. This large intrusive rock mass is believed to be of the Mesozoic age. It intrudes older volcanic and metamorphic rocks at many locations near the project site. Structurally, the Leavenworth Fault is the only major regional feature near the site. The fault, believed to form the western boundary of the Chiwaukum Graben, passes about one mile to the north of the site.

At the project site, bedrock is exposed on both banks of the river. The bedrock is a medium crystalline, closely jointed "salt and pepper" colored diorite, a hard resistant rock. On the left bank, one set of joints dips into the road cuts and river. A small rock slide occurred just downstream from the site on the left bank, since the road cut removed support from the rock mass along the set of joints.

Four unconsolidated deposits overlie bedrock. The first of these is fine alluvium accumulated upstream of the dam. Consisting of fine sands and silts, this deposit is due to the presence of the

dam. The reduced velocities in the small lake behind the dam have allowed these finer sediments to accumulate. The sediment has almost filled the available storage in front of the dam, and is probably about 20 feet deep. Coarse alluvium, the second deposit, is comprised of coarser sands, gravels and boulders; this deposit is below the dam. The thickness of coarse alluvium is not known, though it may be over 10 feet deep in the bottom of the valley. Both abutments show a thin layer of colluvium, the third deposit present at the site. The colluvium is less than 1 foot thick and consists of angular fragments of bedrock in a veneer of sandy soil material. Where rockfalls have occurred, angular fragments occasionally have reached the river, contrasting with the rounded coarse alluvium. The fourth deposit is manmade fill. Until its relocation along the Chumstick Canyon, the railroad ran past the site on the left bank in the present location of the highway. Fill was placed to provide the subgrade and ballast for the railroad. It is believed that the highway was constructed on this fill with little or no change in the fill cross section. The fill, possibly over 15 feet deep near the shoulder of the road, is a strong, free draining material standing on slopes of about one and one-half horizontal to one vertical (1.5H:1V.) Dark in color, it may be an amphibolite borrowed from quarries near Leavenworth.

The existing dam and fish ladder have survived a number of small earthquakes. The site lies within an area characterized by the Corps of Engineers as having potential for minor damage due to earthquakes. Seismic considerations are not expected to control design.

DESIGN AND CONSTRUCTION CONSIDERATIONS

Each of the materials described above, bedrock plus the four overlying deposits, may play a role in the design and construction of the new fish ladder. It is not known what material(s)

forms the foundation for the existing fish ladder. Constructing the new fish ladder in the same general location will not have to overcome problems much different from those encountered in the past. The foundation of the existing ladder appears structurally sound. This is not surprising as the loads imposed by the ladder are light compressive, or bearing, loads. Shearing resistance does not appear to be involved in the design for the foundation; it may, however, be important in the layout of the excavation for construction.

The downstream end of the new ladder may encounter bedrock, coarse alluvium, fill or some combination of these materials, any of which should provide an adequate foundation.

The proposed ladder has a "footprint" wider than the existing ladder. In order to set forms for the left wall of the new ladder, some excavation will have to be made back into what is believed to be fill material. This excavation will have to stand during the construction period until backfill can be placed against the wall. For planning purposes, slopes of about 1.25H:1V should be used for this excavation. Permanent slopes above backfill probably should not exceed 1.5H:lV.

DRYDEN

REGIONAL AND SITE GEOLOGY

The site is located in a broad alluvial valley. Bedrock is exposed on the left bank just upstream from the dam in a railroad cut. The rock is the Swauk Formation, an arkosic sandstone of fluvial origin which is believed to be Cretaceous-Paleocene in age. Bedrock dips steeply under the valley and is exposed nowhere in areas being considered for new fish ladders. Overlying the bedrock is alluvium consisting of silts, sands, gravels, cobbles, and boulders.

During the 1960's hydropower redevelopment study at Dryden, a few borings were made downstream from the dam. In general, these borings encountered only alluvium to a depth of about 100 feet. There is no evidence to suggest significantly different conditions at the proposed new ladder locations. Both new ladders are expected to be founded on alluvium. The previous borings showed that the river tends to armor its bed, i.e., the coarsest material is located in the first 10 feet of the bed. Below that, the alluvium tends to be finer.

Like Tumwater Falls, the site lies within an area characterized by the Corps of Engineers as having potential for minor damage due to earthquakes. The existing dam has survived a number of small earthquakes without apparent damage. Seismic consideration will not be a factor in design.

DESIGN AND CONSTRUCTION CONSIDERATIONS

The alluvium at both ladder locations is expected to provide an adequate foundation, as original structures of similar proportions have survived without serious foundation problems. The only special precaution to be observed is defending discharge areas against scour and consequent undercutting of structures. Suitably proportioned aprons can provide the required protection. The existing ladder at the right bank was reinforced in the fall of 1983 to protect against flood flows between the ladder and bank. Similar care should be taken to protect the new ladder.

The proposed ladder near the canal headworks (see Figure 5) will abut the canal. Behind the existing retaining wall, the canal bank is likely manmade fill. Although alluvium was used for the fill, the bank has sealed itself over the years and is probably watertight. If it is disturbed, some attention should be given to restoring its watertightness, either with natural or manmade materials.

CHAPTER 5
HYDROLOGY AND HYDRAULICS

HYDROLOGY

GENERAL

The Wenatchee River flows from the east slopes of the Cascades in a generally southward direction and enters the Columbia River approximately 2 miles north of the City of Wenatchee. Typical of higher elevation streams, the Wenatchee's flows peak with snowmelt in the spring. The USGS (1980) estimates the drainage area of the Wenatchee River, above Peshastin, to be approximately 1,000 sq. mi. The flood of record is 32,300 cfs which occurred May 28, 1948. The record low flow is 183 cfs which occurred October 14, 1939. The mean annual flow of the Wenatchee River at Peshastin is approximately 3,100 cfs.

TUMWATER FALLS

Data from three USGS gaging stations were used to determine flows at Tumwater Falls Dam, river mile (RM) 30.9. The location map on Figure 1 shows the USGS gages on Icicle Creek, at Plain (RM 46.2) and Peshastin (RM 21.5). The flow at Peshastin gage is approximately 6 percent greater than the combined flow at Plain and Icicle gages. Of the 6 percent difference in flow, approximately 3 percent is due to Chiwaukum Creek, which enters the Wenatchee at RM 36. The remaining 3 percent probably comes from the smaller tributary streams on the Wenatchee. From the location of Tumwater Falls Dam it is estimated that the flow is 4 percent greater than the flow at Plain. Though there are seasonal variations in data correlations between gages, the 4 percent correction applied to Plain gage is well within acceptable accuracy.

A mean monthly flow hydrograph and a flow duration curve for the Wenatchee River at Tumwater Falls, Figures 8 and 9, respectively, were produced from adjusted USGS data at the Plain, WA gage. A computer program developed by OTT called FLODUR was used to create the hydrograph and flow duration curve. The sixty-two years of mean daily flow data, between 1911 and 1974, used in the analysis were obtained from the USGS via computer tape.

Figure 8 shows the snow melt high flow period with peak average flow of 6,856 cfs in June; the low flow period occurs between August and March. A hydrograph of a typical water year, 1969, is shown in Figure 10.

DRYDEN

Peshastin gage, at RM 21.5, is 3.9 river miles upstream of Dryden Dam. Below Peshastin gage, Peshastin Creek adds additional flow to the Wenatchee River. This flow was estimated by Chelan County PUD (1980a) to be 2.5% of the Wenatchee River at Peshastin. USGS data from Peshastin gage, between 1930 and 1981 were adjusted by the 2.5% and used to produce a mean monthly hydrograph, Figure 11, and a flow duration curve, Figure 12, for the Wenatchee River at Dryden Dam. These figures were also produced using FLODUR. Flow data from a typical water year, 1969, is shown on Figure 13.

HYDRAULICS

GENERAL

Hydraulic data necessary for predesign and feasibility are primarily stage-discharge relationships at various locations at the sites. Key areas of interest are fishway entrances and exits. Fluctuations of these water surfaces govern hydraulic design and operation of ladders. Information is also required to

identify potential scour areas. These are principally stage-discharge relations, channel geometry and bed roughness. At the writing of this report, some data for hydraulic calculations have yet to be collected; however, existing information has been used and must be supplemented with additional data in final design.

TUMWATER FALLS

The ogee crest spillway at Tumwater Falls Dam is the hydraulic control of the upstream water surface and, therefore, the fish-ladder exit. The stage-discharge relation can be determined using the standard weir equation (Davis and Sorensen 1969); these results are plotted on Figure 14.

The exit of a new fishway on the left bank of Tumwater Falls Dam would be located approximately where the existing exit is. Data obtained by Berry (1964) shows river stage at flows of 710 and 10,100 cfs at Plain gage. These data, along with a flow of 2,000 cfs obtained by OTT, are plotted on Figure 14 as stage versus discharge and apply to the downstream region of the ladder. This technique for determining tailwater variation is preferred, when possible, as it is direct and does not require simplifying assumptions of uniform flow, bed slope, channel geometry and roughness.

DRYDEN

The upstream water surface, and therefore fishway exits, at Dryden Dam are controlled by the overflow weir. Like Tumwater Falls, the stage-discharge relation can be determined using the standard weir equation; these results are plotted on Figure 15.

The water surface fluctuations at proposed ladder exits have yet to be determined. These stage-discharge relations must be determined with the direct method used at Tumwater Falls.

Calculations assuming uniform flow are erroneous since downstream water surfaces are controlled by plunge pools downstream of the weir.

CHAPTER 6
FISHERIES

GENERAL

The Wenatchee River provides passage, and spawning and rearing habitat for natural runs of anadromous salmon and steelhead trout. Additional production is provided by the federal hatchery on Icicle Creek near Leavenworth which is managed by the U.S. Fish and Wildlife Service. Anadromous fish which pass Rock Island Dam on the Columbia River either continue up the Columbia past Rocky Reach Dam or enter the lower Wenatchee River. Some of these fish spawn in the lower river, while the habitat preferences of others cause them to continue upstream past Dryden and Tumwater Falls dams. The condition and irregular operation and maintenance of the fish ladders at the dams has caused difficulties for the adult fish migrating upstream, especially under certain flow and operational conditions.

Dryden Dam is located in a low gradient, moderately braided reach of the river amidst some usable spawning gravels, while Tumwater Falls Dam is located in a steep gradient canyon, 13.3 miles upstream from Dryden Dam. Fish passing Tumwater Falls Dam continue upstream to spawn in the lower gradient portion of the river and tributary streams between the dam and Wenatchee Lake. Except for an unknown proportion of strays, hatchery returns do not pass Tumwater Falls Dam, but rather enter Icicle Creek above Dryden Dam. A terminal fishery is permitted in some years when a substantial surplus of hatchery fish return to Icicle Creek.

SPECIES

The main anadromous runs on the Wenatchee River consist of sockeye, spring and summer chinook salmon and steelhead trout. Coho

salmon were reared and released by the Leavenworth National Fish Hatchery resulting in some returns of adult coho to the system. This program was discontinued in the early 1970's, however, and a significant mainstem coho run has apparently not persisted. The Leavenworth hatchery raises mainly spring chinook with annual production of roughly 2.5 million smolts (Mullan 1982). Other spring chinook spawn in Icicle Creek downstream of the hatchery or in the Wenatchee River, between the two dams and above Tumwater Falls Dam. Summer chinook spawn below Dryden Dam, between dams and between the pool behind Tumwater Falls Dam and the Highway 2 bridge near Chiwaukum Creek, about four river miles upstream. Sockeye spawn upstream of Tumwater Falls Dam, generally in streams tributary to Wenatchee Lake. There is little recent information on coho salmon. However, coho counts at Rock Island and Rocky Reach Dams indicate that about 1,000 fish per year (widely variable) are available to run up the Wenatchee River system. Counts are often very low (zero to a few hundred) for several years running (Leman 1980). If coho are present, they probably spawn primarily below Dryden Dam with a few passing through Tumwater Canyon to spawn in upriver tributaries. If a substantial coho run were to be reestablished in the system, it is expected that a significant proportion would have to pass both Dryden and Tumwater Falls dams.

The sockeye run typically ranges between 15,000 and 50,000 fish and is one of the two largest sockeye runs in the Columbia River System. The other, usually larger run, is supported by the Okanogan River (Mullan, no date). Natural spring chinook runs range from 2,500 to over 12,000 fish (average approximately 5,600 fish). Estimated summer chinook runs on the Wenatchee have a similar range of about 4,000 to 10,500 fish annually (lo-year average approximately 7,000). Steelhead production is typically 4,000 to 5,000 fish annually.

MIGRATION AND SPAWNING HABITS

Spawning and migration habits are considerably different for each species. Sockeye salmon spawn primarily in tributaries to Lake Wenatchee, although a few riverine spawners are known to utilize the mainstem Wenatchee River and Nason and Icicle Creeks (Mullan, no date). Only limited spawning of naturally reproducing spring chinook occurs below Tumwater Falls Dam, primariy in Icicle Creek and Peshastin Creek. At least 80 percent of the spring chinook spawning occurs above Tumwater Falls Dam. About 30 percent of the successful summer chinook spawners are found in the mainstem below Dryden Dam, about 60% are found between Dryden and Tumwater Falls dams, and about 10% are found above Tumwater Falls Dam. Steelhead trout spawn in various tributary streams; most of the run is thought to use tributary streams above Tumwater Falls Dam. Certain other life history information on various anadromous fish stocks in the Wenatchee system is summarized below.

CHINOOK

Adult spring chinook migrate during the period May through June with spawning occurring from mid-August through September. Rearing occurs year-round, with out-migration concentrated during April and May. Adult summer chinook run during the period mid-June through August, reaching Tumwater Falls Dam in August and September. Summer chinook begin spawning during September, continuing into October. Summer chinook fry emerge in late spring and rear primarily in the mainstem. Juveniles out-migrate from June through October.

SOCKEYE

Sockeye run timing overlaps that for summer chinook, beginning slightly later in July. Adults reach Tumwater Falls Dam in early August and continue passing the dam through early September.

Sockeye juveniles rear year-round in Wenatchee Lake, and two-year-old juveniles begin downstream migration during April and May.

COHO

Timing for any coho which may be present in the system is presumed to be similar to other areas on the Columbia. Migration probably occurs in September and October with spawning continuing into November. Coho rearing is year-round, with juvenile out-migration occurring during late spring.

STEELHEAD

Based on fish counts (Washington Department of Game, unpub.) and information in the Dryden Draft EIS, (Chelan County PUD 1980a), summer steelhead occur in the Wenatchee system. The steelhead run begins in early July with the majority of fish entering the system from August through October. Adults hold through the winter and spawn from late March through early June. A few fish overwinter in the Columbia River and run up the Wenatchee in the spring as water temperatures rise (S. Hays, pers. comm.). Rearing is year-round with out-migration of yearling or older juveniles occurring in the spring.

In addition to anadromous species, the mainstem Wenatchee River contains resident rainbow trout, mountain whitefish and Dolly Varden char. The Washington Department of Game planted Brown Trout in the system beginning about 1980. Since there is little evidence of survival in the past two years, and none of successful reproduction, the practice has been discontinued.

Resident fish supply an active sport fishery, as do steelhead. Historically, about 30-50 percent of steelhead runs, averaging about 2,000 adults in recent years, are harvested by anglers. Washington Department of Game has periodically imposed restrictions on steelhead fishing above Tumwater Falls Dam due to small run sizes. These restrictions were imposed to increase spawning escapements and to protect fish on their spawning grounds. A substantial increase in run size occurred in 1983. The run was estimated by WDG at 8,000 fish; harvest data were not available at the time of writing. About 100,000 summer-run two-ocean Skamania stock steelhead juveniles were reared and released into the Wenatchee system in 1982 and 1983 by Chelan County PUD as part of a three-year cooperative pilot program with WDG. A tentative agreement for a permanent program is awaiting approval by the Department. The first returns from these plantings are due the summer of 1984. Expected survival is about 1 percent or 1,000 adult fish (S. Hays, pers. comm.). A new management strategy seeks to increase steelhead spawning escapement and eventually run strength by limiting harvest to 20 percent of the total run. Target spawning escapement for this strategy is 8,000 fish.

PROBLEMS WITH EXISTING PASSAGE FACILITIES

Each of the dams present significant passage problems to anadromous fish. The principal problems are due to dam configurations, placement of ladders, inadequate flow regulation in ladders and decay of existing facilities. These problems result in stress, delay, injury and probably associated mortality. During recent observations of facilities, the following site specific problems have been noted.

TUMWATER FALLS

- The downstream section of the existing ladder has been battered by flow, gravel and ice. As a result, the lower portion of the right wall is broken and spillway flow competes with ladder flow. The spillway flow then creates a barrier to fish at higher flows.

- Ladder flow, regulated by stop logs, is often too high or too low for proper ladder operation and, ultimately, fish passage. The key difficulty is proper placement of stop logs with continually changing flow. At low flows in the ladder, fish can encounter insufficient dissolved oxygen. This phenomenon has been observed. During high flow events the ladder itself can be a barrier.

- The volume of fishway pools, approximately 150 ft3, is not adequate to provide both volume for energy dissipation and quiet areas for fish to rest. The accepted criterion (Bell 1980) is 1 ft3 of pool will dissipate 4 ft-lb/sec of power. If this criterion is adhered to, the maximum fishway flow for 150 ft3 of volume should be approximately 10 cfs.

- When ladder flow is properly regulated, attraction flow is insufficient to compete with spillway flow.

- Changes in spillway alignment and discontinuities in the apron below the spillway cause flow concentrations on the apron. These flow concentrations appear as jets on the apron, seen in Figure 4, that extend to the pool below. Fish have been observed jumping at these sources of false attraction.

DRYDEN

- The left side of Dryden Dam, the timber crib portion furthest downstream, is approximately 8 ft high and has no fishway. The original fishladder was washed out by the 1948 flood and never replaced. Fish approaching this side of the dam, separated by the island, encounter a substantial barrier. These fish must drop back and go around the island to pass upstream.

- The existing right bank ladder has inadequate flow control. Like Tumwater Falls, flow is controlled by stop logs. Even if proper flow control is maintained, the attraction flow is inadequate.

CHAPTER 7
ALTERNATIVE FORMULATION AND EVALUATION

The gamut of possible fish passage alternatives include fish ladders, locks, barrier removal, trap and haul, and cable ways. Although the latter four alternatives have been successfully applied in other instances, the Tumwater Falls and Dryden sites are not well suited to these techniques. Therefore, only fish ladder schemes have been seriously considered in this study.

CRITERIA

ABILITY TO PASS FISH

If a fishway is to pass fish, the entrance as well as the fishway must be attractive to fish. The entrance jet or flow must have sufficient momentum to compete with ambient flow and thus attract fish. The flow required is site specific; however, the standard for velocity, as noted by Bell (1980), is 4 to 8 feet per second (fps). As well as entrance flow and velocity, entrance position is also important. Throughout the design range of flow at a site the fishway entrance must be accessible to fish; this is often accomplished by providing more than one entrance. Finally, if an entrance is to be effective, there should not be components of velocity normal to it greater than 1 to 2 fps and preferably only components of velocity parallel to it.

Much of the design criteria for fishways has been compiled by Bell (1980). Pertinent criteria are listed with some explanation as follows:

- The maximum drop between pools of a weir and pool or slot and pool fishway should be 1 ft. Violat ion of this criterion can stress fish and prevent weaker fish from further migration.

- The volume of fishway pools should be such that the energy of the flowing water is dissipated in each pool. The rule of thumb is 1 ft3 of pool will dissipate 4 ft-lb/sec of power.

- Sufficient regulation should be provided to ensure the fishway will properly operate under all flows at which fish are migrating. Variations in ladder entrance and exit water surfaces can be controlled with adjustable weirs and gates or through use of vertically slotted weirs.

- Transport velocities in flooded or level areas of the fishway should be on the order of 1 to 2 fps over the gross area of the fishway. This provides attraction for fish to move through the fishway, though not impeded by high flow velocities.

- Any orifices, slots or trashrack openings must be large enough to pass fish. Generally 9 to 12 in. is adequate for anadromous fish.

Fishway flow and sizing should also consider the timing of fish movement and oxygen requirements of fish. At any time when fish are passing through a ladder, the volume of pools should be sufficient to comfortably hold fish. In addition, the dissolved oxygen in water must be adequate for fish needs. Relatively short fish ladders, as required at the Tumwater Falls and Dryden sites, generally do not have a controlling oxygen requirement since fish pass quickly through such facilities. The following criteria were adapted from Bell (1980) and apply to fish timing, pool sizes and oxygen requirements.

- In any one day 10% of the total run could pass, and 10% of the day's fish could pass in one hour. It should be noted that daily peaks do occur in excess of 10%; e.g., in early August of 1966, 18% of the Wenatchee River sockeye run occurred in one day.

- Pools should allow, at a minimum, 3 ft3 per adult fish or 0.2 ft^3 per pound of fish.

- Fish spend between 2.5 and 4.0 minutes in each pool of Ice Harbor, weir and pool or slotted fishways.

- Adult fish oxygen requirement during active swimming is approximately 40 x 10'4 oz/hr/pound of fish, during normal activity this drops to 24 x 10-4. The dissolved oxygen concentration of fresh water at 50° F is approximately 0.012 oz/ft3 at mean sea level. Conservatively, 50% of the available dissolved oxygen is useful to fish.

The criteria mentioned in this section are relatively easy to satisfy in design, and should keep fish delay and stress at a minimum.

ADAPTABILITY TO HYDROPOWER

As stated in Chapter 3, there have been Preliminary Permits filed with the Federal Energy Regulatory Commission for redevelopment of both Tumwater Falls and Dryden sites by T. Forbes of Hydro Energy Associates, as well as the City of Sultan on Tumwater Falls. Also, Chelan County PUD has stated that they may wish to rehabilitate the sites when economic conditions make it feasible (pers. comm., Roger Purdom). In view of this, fishway schemes also should be evaluated on their ability to adapt to hydropower.

Requirements for hydropower are not difficult to meet, since redevelopment plans for both sites include diverting water at the dams to powerhouses some distance downstream. The fundamental requirements, as stated by Chelan County PUD and Dryden Associates, are as follows:

- 0 Fishway flows should stay within the instream flow requirements at each site.

- 0 If possible, the head available to hydropower production should not be decreased with fishway redevelopment.

- 0 The right bank of Tumwater Falls Dam should be left open for juvenile screening needs.

- 0 The canal and headworks at the left bank of the Dryden Dam should not be disturbed in such a way as to interrupt irrigation service or preclude flow to the old powerhouse site.

AGEEJCY COORDINATION

Comments on this project have been received from a number of sources including Washington State Department of Fisheries, Washington State Department of Game, National Marine Fisheries Service, U.S. Fish and Wildlife Service, Chelan County PUD, Yakima Indian Nation, Colville Confederated Tribes, and Dryden Associates. Through meetings and telephone conversations, a number of comments have have been made by the above agencies as to biological and engineering aspects of the project. The biological input and concerns have dealt with issues of run timing and strength, stock degradation through injury and delay at sites, and enhancement of fishery resources. Comments on

engineering aspects have included pool design (geometry, size, flow, and placement), auxiliary attraction flow, entrance configurations and construction timing and techniques. The biological and engineering comments, where appropriate, have been incorporated throughout this study.

ALTERNATIVES CONSIDERED

FISHWAY TYPES

In general, there are four types of fishways in common use, they include Denil type, weir and pool, Ice Harbor and vertical slotted. Each of these designs are discussed as to their applicability to the Tumwater Falls and Dryden sites.

Denil Fishway

The Denil fishway is an open flume with baffled walls and floor. The baffles are oriented in such a way to create return flow at the walls and floor which slows the core flow. The fishway can then be set on a relatively steep slope, usually 6H:lV, and maintain a maximum velocity less than 4 fps. Since there are no pools or resting areas in Denil sections, the ladder must be provided with resting areas after approximately 30 ft of run. The Denil has the advantage of operating over a range of 3.0 to 3.5 ft of headwater fluctuation, which is adequate to cover the range of flows at both the Tumwater Falls and Dryden sites. There are, however, two difficulties with the Denil; problems with passing sediments and debris, and relatively high operation and maintenance costs. Difficulty in passing sediments is a concern as both impoundments are heavily laden with sediments which will move into the fishways during higher flows.

Weir and Pool Fishwav

Existing fish ladders at Tumwater Falls and Dryden dams are of this type. They are a series of pools with water flowing from pool to pool over rectangular weirs *or* stop logs. As the headwater fluctuates, the fishway flow must be regulated by adjustable weirs, stop logs or orifice controls. Like the Denil type, standard weir and pool fishways will not readily pass bed loads and must be designed with bottom orifices if this is a concern. As mentioned by Bell (1980), weir and pool systems can oscillate between streaming and plunging flow which is an instability appearing as roll waves on the fishway surface that can compound to a point where the fishway is useless. This problem can be avoided with proper design; however, flow regulation and sedimentation remain as major problems.

Ice Harbor Fishway

The Ice Harbor design is a modified weir and pool type. The weir section has either one or two orifices in the bottom that will pass bed loads as well as fish. Fish generally prefer orifices to jumping over weirs. The upstream side of the *weir* is provided with two baffles oriented normal to the weir and parallel to the general direction of flow. Due to the baffles, orifices and weir crest shape, the unsteady flow problem mentioned in the previous paragraph does not occur. Like the weir and pool fishway, the Ice Harbor design requires flow regulation.

Vertical Slotted Fishway

The slotted fishway is fashioned with vertical slots, usually 12 in. wide, that will pass debris, bed load, and fish, as well as regulate flow over a wide range of tail and headwater fluctuation. The slope of the slotted fishway is set such that during

the maximum water surface difference, between head and tailwater, the head loss per pool is 1 ft. The head loss per pool for a smaller water surface difference is less than 1 ft. The vertical slots will not maintain a constant discharge over the range of water surface fluctuation; however, hydraulic characteristics of the fishway are constant and therefore useful to fish over the design range of flow.

For the Tumwater Falls and Dryden sites, the slotted fishway is the preferred choice. It has the operation characteristics necessary for these sites, capital costs are comparable with other designs and annual costs are the least among alternatives. The various agencies consulted on this project concur that the slotted fishway is the best alternative.

TUMWATER FALLS

Two passage alternatives have been considered at Tumwater Falls. The first alternative, see Figure 16, involves a single slotted fishway at the left bank. The second alternative involves slotted fishways at both the right and left banks, as shown in Figure 17. The following sections discuss both alternatives and the reasons for recommending the former.

Alternative 1, Left Bank Fishway at Tumwater Falls

A single slotted fishway at the left bank of Tumwater Falls Dam would have the entrance at the furthest upstream point of the barrier. This is the most desirable location. The ladder would operate with three entrances as shown in Figure 16. The two lower entrances would provide attraction for fish coming straight up the channel or from the right side of the pool below the dam. The upper entrance would allow more flexibility during higher flow situations. The lower entrance pool would be used for

adding attraction flow in excess of fishway flow. The operation flow in the fishway will vary from 25 to 40 cfs, depending on the head across the ladder. The attraction flow added to the last pool is 100 cfs. Approximately 40 cfs would also be added to the seventh pool to supply the upper entrance.

In general, fish ladder pools are longer than they are wide. In this case, however, the fishway length is constrained by site conditions and pools are 8 ft long and 12 ft wide. This will provide adequate resting area for fish and volume for energy dissipation.

It was mentioned in Chapter 6 that jets appearing on the dam apron under low and medium flow situations falsely attract fish. This problem may be solved by an arrangement of baffle blocks on the apron, crest modifications at discontinuities in the structure or some combination of both. Possible solutions should be tested with a physical hydraulic model as the hydraulics are complicated and alternative solutions cannot be analyzed without hydraulic modeling. In addition to the jets, a better understanding of the ladder entrances, attraction flow and ambient flow interaction can be obtained with the model study.

Alternative 2, Right and Left Bank Fishways at Tumwater Falls

Discussion in this section is limited to the right bank fishway, as the left bank facility was discussed in alternative 1. Fish would enter the ladder on the apron as noted in Figure 17 and continue through the 18 pools to the forebay. The ladder would operate over a range of flows between 300 and perhaps 10,000 cfs with flow regulation provided by the vertical slots. Pools would be 6 ft wide by 10 ft long with flows between 25 and 40 cfs.

The right bank fishway has the advantage of passing those fish which typically approach that side first. This would decrease delays associated with fish finding the other ladder, and perhaps mitigate stress and injury resulting from fish jumping at the dam.

There are however, economic and logistic problems with the right bank ladder since construction on that side would necessitate crossing the river with materials and equipment. This would require a temporary road to a dry work area downstream of the ladder with culverts to pass the river flow. A 6 ft wide by 4 ft high notch would be cut through the dam crest to accommodate fish passage facilities. Tailoring of the crest would also be required to prevent spills onto the fishway. This would involve raising the right-most section of the spillway and lowering the other sections. Raising a section of the dam may compromise the structural stability of the dam as well as create higher backwater. Either of these effects is undesirable.

It is estimated that a right bank fishway would cost $600,000 more than the left bank facility. This figure includes the total capital costs of design and construction projected to BPA's FY 1985; inflation of 7% annually was used. The least desirable aspect, however, is operation and maintenance. The right bank is currently accessible only by boat or a two mile hike over a foot bridge. This access would not permit maintenance by heavy machinery and would make routine maintenance difficult. This would compromise fishway utility.

Recommendation

A fish ladder should be provided at the left bank as site conditions and natural tendancy of fish dictate this. The concern then is whether a right bank ladder is necessary. Investigations up to this time indicate a single left bank ladder would suffice

if the remainder of the apron is made unattractive to fish. This should be the case with the elimination of the jets. A right bank fishway would then not be necessary and the additional capital costs as well as the operation and maintenance difficulties could be avoided. The recommendation for Tumwater Falls Dam is then Alternative 1, a single left bank slotted fishway.

As well as solving the fish passage problems, Alternative 1 is not competitive with hydropower development at Tumwater Falls. The general layout as proposed on Figure 16 has been discussed with both Chelan County PUD and Dryden Associates. Neither of these groups have raised any objections to this alternative.

DRYDEN

Considering passage requirements and cost effective design, there is one reasonable fish passage scheme at Dryden Dam. This involves slotted fishways at the right bank, at the approximate location of the existing fishway, and at the left bank adjacent to the canal.

As shown in Figure 18, the right bank ladder would have six pools and the left bank ladder ten. The ladders would operate over Wenatchee River flows between 500 and 12,000 cfs. Entrance pools at both fishways would receive auxiliary water for fish attraction of 100 cfs. The proposed fishway pools would be 8 ft wide by 10 ft long with flows between 25 and 40 cfs. As mentioned in Chapter 6, fish approaching the different sides of the Dryden structure are separated by a gravel bar. The new fishways proposed would allow fish to pass the structure from either side of the bar with little difficulty. Ladder entrances will be placed downstream of the spillway sections far enough to avoid areas of high turbulence and air entrained flow; this practice makes entrances more useful to fish. Both ladders would be provided with two entrances which are parallel and normal to the

spillway flow. The entrances discharging normal to the spillway flow must be further analyzed, since they may be difficult for fish to use with competing spillway flow.

The criteria for time spent in each fishway pool, holding requirements, dissolved oxygen consumption and peak run timing were used to calculate the maximum run size a fishway will accommodate. This is difficult to determine, however, conservative estimates of fishway capacity indicate the Dryden ladders would not limit fish runs of realistic sizes. The same is true for the Tumwater Falls ladder.

The placement and operation of the proposed Dryden ladders has been discussed with both Chelan County PUD and Hydro Energy Associates, neither of whom have raised any objections or consider the layouts competitive with hydropower redevelopment.

PROJECT LAYOUTS

The discussion and layouts in this section are for planning purposes and should not be interpreted as being final. The intent is a conceptual understanding at a level sufficient for preliminary construction estimates. The designs represent functional schemes which would adequately serve both sites. However, significant refinements should be expected in final design.

TUMWATER FALLS

The general layout of the proposed Tumwater Falls fishway and its relation to existing project facilities is seen on Figure 16. Bold lines represent the proposed facilities and faded lines represent existing facilities which will be removed. From Figure 16 it can be seen that the new fishway lies in the same area as the old fishway, with the exception of the lower five pools. The

intent of realigning the lower section is to provide easier access for fish and to protect the entrance from being buffeted by flow over the spillway.

The principal features of the design are shown in more detail in Figures 19 and 20. The ladder headworks include trashracks sloped 60° from the horizontal. Spacing between trashrack bars is 9 in. for the ladder and 7/8 in. on the auxiliary water supply.

There are 19 pools, 18 of which have nominal dimensions, 8 ft by 12 ft, the entrance pool is approximately 21 ft by 12 ft. The slope of the fishway is approximately 10H:lV. The walls, slotted weirs, slabs and footings will be reinforced concrete. The required wall and slab thicknesses will be determined in final design. The possibility of precasting all or most of the vertical slots should also be investigated in final design as considerable construction savings could be made. The entire fishway would be covered with a galvanized steel grating for safety and to help prevent poaching.

The auxiliary water supply system includes a trashrack and valves that will control the flow to both diffusers (see Figure 20). Transitions from the conduits to the diffusion chambers are round to rectangular; baffles are provided downstream of the expansions to diffuse the jet. Vanes are placed in the walls between diffusion chambers and ladder pools. Their purpose is to guide flow from the diffusion chamber into the fishway pool and to prevent fish from passing into the diffusion chamber. The clear space between vanes is 1 in. and the velocity over the gross cross-section is 1 fps.

The forebay area upstream of the ladder will be excavated for the ladder exit, auxiliary water intake and trashrack. These areas and some distance upstream must be riprapped to prevent scour. The area downstream of the lower ladder entrance must also be riprapped to protect against scour.

Civil site work required will be limited to fencing and providing parking areas.

DRYDEN

Right Bank Ladder

The proposed right bank fishway at Dryden Dam, shown in Figures 18 and 21), is bordered by the stream bank on one side and a trash sluice on the other. The trash sluice, seen in Figure 21, is part of the existing facility. Investigations up to this point indicate the trash sluice is structurally sound and need not be replaced. (The trash sluice is presently used to help dewater the timber crib sections during repairs, and would serve to sluice gravels away from the proposed auxiliary water intake.) The new fishladder would be constructed at the same location as the old fish ladder, but would extend some 60 ft further upstream.

As shown in Figure 21, the principal features include the ladder and entrance pool, trashracks and diffusion chamber. Of the six pools, five are nominally 8 ft wide by 10 ft long in the direction of flow. The entrance pool is 8 ft by 25 ft. The slope of the ladder floor is l0H:0,83V. Both trashracks at the ladder entrance and diffusion water intakes are sloped 60° from horizontal. Clear space between trashrack bars is 9 in. for the ladder exit and 7/8 in. for the diffusion intake. A sluice gate will be used to control flow into the diffusion chamber. Like

the Tumwater Falls system, there are jet diffusing baffles downstream of the diffusion water conduit. The design criteria for the diffusion vanes is the same as discussed for Tumwater Falls.

The design flow range is 500 to 12,000 cfs. The variation in tail and headwater over that range of flow controls the design of pool wall heights and number of pools. The stage-discharge relation for tailwater must be refined. Updated stage-discharge information may change the number of pools required and their wall heights.

Left Bank Ladder

Details of the left bank ladder are shown in Figures 22 and 23. The ladder configuration is somewhat different than the Dryden right bank or Tumwater Falls designs. As Figure 22 shows, fish enter the ladder at the base of the timber crib and gain elevation while traveling in the downstream direction. The 3 ft wide channel then carries fish from the upper pool, number 10, into the reservoir.

Sections through the fishway and canal are shown in Figure 23. The retaining wall between the canal bank and fishway is in the same position as the existing wall. The old wall will be replaced because it is in poor structural condition. Cutoff walls are provided on the stream sides of the fishway and trash sluice to prevent scour from undermining the structures.

A new trash sluice adjacent to the diffusion chamber replaces the old trash sluice that must be removed. Fishway pool operation and design, as well as trashracks and diffusion chambers, are similar to the right bank facilities discussed earlier.

Both Dryden ladders will be covered with galvanized grating for safety and to help prevent poaching. Fencing will probably not be required, since these are not high public use areas like Tumwater Falls. Some civil site work will be required, however. This will include parking and walkways, along with a pathway for rafters to pass around the dam and fishway at the right bank.

OTHER ALTERNATIVES

Thought has been given to less costly alternatives than discussed in the earlier sections of this chapter. Those alternatives involve repair of existing passage facilities at both Tumwater Falls and Dryden sites, and construction of a new left bank passage facility at Dryden. Repair of existing facilities is feasible, as well as provisions for auxiliary water. The costs associated with this repair would be somewhat lower than total replacement, however, many of the major cost items, such as dewatering, would remain. Additionally, the repair of existing facilities cannot be viewed as a long-term solution to passage difficulties a+ either site. The inherent problems of insufficient pool volume, flow regulation and continual maintenance would not be solved. In view of the perpetual commitment to the fish resources of the Wenatchee River, complete replacement of existing facilities is the most viable solution.

CHAPTER 8
CONSTRUCTION PLAN AND COSTS

CONSTRUCTION ASPECTS AND SCHEDULES

GENERAL

Construction of fish facilities at Tumwater Falls and Dryden Dams will be influenced by a number of factors. The principal concerns are listed as follows with some explanation.

Dewatering

The seasonal fluctuation of the Wenatchee River provides a natural low-flow construction window. Figures 8 and 11 show the window between August and March. Construction within the low-flow period will considerably reduce dewatering costs. Investigations up to this point indicate that embankment cofferdams can be used for dewatering at each site. If suitable material is available, the fill could be dispersed and left in the stream after construction is complete. The objective of this is not to destroy any spawning habitat but to enhance, in a limited amount, existing habitat. The enhancement would require most embankment materials to be between 1 and 4 in. in diameter, relatively rounded, with a small percentage of fines. If suitable embankment material cannot be found, it will be removed from the stream after dewatering.

If cofferdam materials are free of fines or slopes are exposed to stream velocities in excess of 3 to 4 fps, a waterproof membrane would be required on the stream side of the embankment. The membrane would help to prevent scour of embankment materials and seepage through the cofferdam. It may also be required to extend

the membrane some distance beyond the toe of the embankment to decrease seepage around and beneath the fill.

During the fall and winter of 1983, two embankment and membrane cofferdams were used on the Okanogan River near Tonasket, Washington. The Okanogan River is a sockeye stream with a formidable run. This suggests that the embankment and membrane cofferdam system can be compatible with anadromous fish requirements. The particular dewatering schemes will be discussed in later sections.

Run Timing and Temporary Passage

Construction of new facilities in the same location as existing ladders would disrupt fish passage during construction. Clearly, if fish are present, temporary passage should be provided at both sites. During the low-flow period, August through March, both salmon and trout are migrating (Chelan County PUD, 1980a). As this is the only reasonable construction window, temporary passage must be provided at both sites. Possible temporary passage schemes will be discussed later.

Weather

Neither Tumwater Falls or Dryden Dam are at particularly high elevations, 1,487 and 969 ft, respectively. Winter months, however, are harsh and should be avoided for construction if possible. If construction contracts are awarded early enough in the summer, there should be no significant difficulty with weather.

TUMWATER FALLS

Construction at Tumwater Falls could begin in August. One scenario is as follows:

- Construction contract awarded on or before July 31 with contractor mobilization beginning immediately after contract award.

- Site preparation of Tumwater Falls left bank will involve removing the existing house and fences, and grading and clearing an area for off-road parking and construction staging.

- Temporary fish passage during construction can be provided at the right bank by passing fish through the old log sluice (see Figure 2). This would first require some rehabilitation of the log sluice, after which a temporary Denil fishway could be built in the area of, and through the log sluice. Preliminarily, the 25 ft of head at the right bank would require five 30 ft run sections of Denil set on a 6H:lV slope and four resting pools between run sections. For temporary use, the Denil could be built of wood or prefabricated sections could be used.

- Dewatering can begin after the temporary fish passage is in place and operating. The training wall at the left abutment of the spillway will dewater most of the new construction; the intake and exit areas will require embankment cofferdams as shown in Figure 24. The particular dewatering scheme is, however, the responsibility of the contractor and may be different from that suggested here.

- Demolition and excavation can begin once dewatering is completed. The entire existing ladder must be removed and areas of new construciton excavated. Excavated materials may require hauling to waste areas off-site since space is limited.

- Form work and concrete placement can begin after excavation, and could run concurrently to some extent. The major concrete work includes slabs, fishway walls and slots, inlet area, and diffusion chambers.

- Channel and apron work necessary to eliminate false attraction (i.e., baffle blocks on the apron, spillway crest modifications, placement of boulders in the stream, etc.) will run intermittently throughout the project. It will require dewatering various portions of the apron for short periods of time to accomplish this work.

- Once the east fishway wall and diffusion chamber concrete is placed, the backfill and pipe installation adjacent to the fishway can begin. The placement of trashracks and fishway grating can also follow the concrete work.

- Cofferdams can be breached and dispersed in the stream or the fill hauled off-site. The temporary facilities can also be removed at this time.

- The project will be completed with civil site work, including walkways, parking areas for visitors and maintenance personnel.

A schedule of the construction activities outlined above is provided in Figure 25.

DRYDEN

Construction activities at Dryden could begin as early as August on the right bank, but no earlier than October 15 on the left bank since irrigation flow in the canal must be maintained. The items in the schedule of activities are described as being either

right bank, left bank or common to both. As shown in Figure 26, the common items are Engineering and Inspection, and Mobilization. The engineering task will run from final design, through bidding and construction. The inspection noted in Figure 26 will run through the construction period. A brief explanation of major construction activities follows.

Right Bank

- Site preparation required at the right bank is minimal. The existing area is suitable for equipment storage, parking and material storage.

- Temporary fish passage at the right bank is the first construction task. Passage could be provided at the upstream end of the concrete weir (see Figure 27). It could be accomplished with four temporary pools placed along the west side of the wall.

- Dewater ing can begin after the temporary passage is in place. As at the Tumwater Falls site, embankment cofferdams could be used. A possible arrangement of cofferdams is shown in Figure 27. After initial dewatering, some pumping will be required during formwork and concrete placement.

- Once dewatering is completed, demolition of the existing fishway and excavation can begin. The west wall of the trash sluice will be left intact and the timber crib will not be disturbed.

- The principal concrete work includes fishway slabs, walls and slots, and the diffusion chamber.

- Placing of miscellaneous metals, trashracks, sluice gate, grating and handrails would parallel and follow the concrete work.

- Structural backfill or sheet piling would be placed between the bank and west wall of the fish ladder.

- The cofferdams may be either removed or dispersed in the stream after the major structural work is completed. Riprap would be required at the ladder intake area, diffusion water intake area and at the ladder entrance.

- The right bank activities would be completed with the removal of cofferdams, riprap and civil site work. The necessary civil site work should involve no more than maintenance access and restoring disturbed areas.

Left Bank

The sequence of most construction activities between Dryden right and left bank ladders is the same. They would differ only by the start-up time and access across the canal. It is necessary to begin left bank activities after the irrigation season, October 15, since the right canal wall will be removed for approximately 100 ft downstream of the gatehouse during construction of the ladder. Figure 27 shows the temporary access road across the canal. After the irrigation season a portion of the canal could be filled to provide access across it. Culverts should be placed in the fill to ensure water supply to the canal in the event construction was delayed into the following spring.

Close coordination will be required with the Burlington Northern Railroad, since construction equipment and materials must be transported across the railway. This may require a Burlington Northern employee to monitor construction activities in the immediate area of the railway.

COSTS

CAPITAL COSTS

The capital costs considered in this report are for construction and engineering services. The capital costs of construction are separated into eight items. A 10% contractor overhead and profit and 20% contingency are added to the total of these costs. The engineering services are separated into four categories. Contingencies are not added to these items. The expected date of construction is 1985. Therefore, the estimates which were made in 1984 dollars are escalated to 1985 with an annual inflation rate of 7%. Tables 1 and 2 show the itemized capital costs for Tumwater Falls and Dryden facilities, respectively. The total 1985 capital costs are $933,000 for Tumwater Falls and $946,000 for Dryden Dam facilities.

The quantities and unit costs reported in Tables 1 and 2 are predesign estimates. Unit and lump sum costs were obtained from suppliers, contractors, Dodge Guide (1983) and recent cost estimating experience of Ott Water Engineers, Inc.

ANNUAL COSTS

As owners of the sites, the annual costs (operation and maintenance costs) for new fish facilities would be borne by Chelan County PUD, provided the new facilities do not require exceptional care (pers. comm., Roger Purdom). Ladders proposed in this report would require the least Operation and Maintenance of any design and therefore should be acceptable to Chelan County PUD. Since BPA will not be responsible for annual costs, they have not been reduced to a single capital cost in 1985 dollars and included in the total project cost. The annual costs have been estiamted, however, and included in the Benefit/Cost Analysis, Chapter 10.

Table 1. --Capital Costs for Construction and Engineering at Tumwater Falls

ITEM	UNIT	QUANTITY	UNIT COST	TOTAL COST
MOBILIZATION & DEMOBILIZATION	LS	---	$12,000	$ 12,000
DEWATERING				$ 55,000
Sandbagging	LS	---	7,000	7,000
Pumps & Maint.	LS	---	8,000	8,000
Cofferdams	LS	---	35,000	35,000
System Maint.	LS	---	5,000	5,000
DEMOLITION				$ 15,000
Concrete Removal	LS	---	12,500	12,500
Hauling Rubble	CY	500	5	2,500
EARTHWORK				$ 43,000
Excavation, Rock	CY	980	25	24,500
Excavation, Common	CY	500	15	7,500
Backfill	CY	700	8	6,000
Riprap	CY	200	25	5,000
REINFORCED CONCRETE				$158,000
Mass	CY	70	100	7,000
Slab	CY	220	250	55,000
Walls	CY	275	350	96,000
METALS				$118,000
Trashracks	LS	a--	10,000	10,000
Diffusers	LS	---	7,000	7,000
Grating	SF	2,800	20	56,000
Piping	LS	---	30,000	30,000
Fencing	LF	250	20	5,000
Valves	LS	---	10,000	10,000
TEMP. PASSAGE	LS	---	50,000	$ 50,000
CHANNEL & APRON WORK	LS	---	25,000	$ 25,000
CIVIL SITE WORK	LS	---	10,000.	$ 10,000
Subtotal				$486,000
10% Contractor O&P				49,000
20% Contingency				107,000
TOTAL				$642,000

Table 1 .--Continued

ITEM	TOTAL COST
ENGINEERING SERVICES	
NEPA Compliance	$ 20,000
Permits	15,000
Design	
Basic Services	60,000
Geotechnical Investigation	25,000
Model Study	60,000
Surveying	10,000
Inspection	40,000
TOTAL	$230,000
ESCALATION FOR 1 YEAR (7%)	$ 61,000
TOTAL PROJECT CAPITAL COSTS IN FY 85	$933,000

Table 2. --Capital Costs for Construction and Engineering at Dryden

ITEM	UNIT	QUANTITY	UNIT COST	TOTAL COST
MOBILIZATION & DEMOBILIZATION	LS	---	$12,000	$ 12,000
DEWATERING				$100,000
Sandbagging	LS	---	5,000	5,000
Pumps & Maint.	LS	---	15,000	15,000
Cofferdams	LS	---	70,000	70,000
System Maint.	LS	---	10,000	10,000
DEMOLITION				$ 23,000
Concrete Removal	LS	---	20,000	20,000
Hauling Rubble	CY	500	5	3,000
EARTHWORK				$ 31,000
Excavation, Common	CY	500	15	8,000
Excavation, Mass	CY	1,100	10	11,000
Backfill	CY	200	8	2,000
Riprap	CY	400	25	10,000
REINFORCED CONCRETE				$192,000
Mass	CY	50	100	5,000
Slab	CY	200	250	50,000
Walls	CY	390	350	137,000
MENTALS				$ 97,000
Trashracks	LS	---	12,000	12,000
Diffusers	LS	---	3,000	8,000
Grating	SF	3,100	20	62,000
Sluice Gates	LS	---	7,500	15,000
TEMP. PASSAGE	LS	---	40,000	$ 40,000
CANAL CROSSING	LS	---	20,000	$ 20,000
CIVIL SITE WORK	LS	---	15,000	$ 15,000
Subtotal				$530,000
10% Contractor O&P				53,000
20% Contingency				106,000
TOTAL				$689,000

Table 2 .--Continued

ITEM	TOTAL COST
ENGINEERING SERVICES	
NEPA Compliance	$ 20,000
Permits	15,000
Design	
Basic Services	75,000
Geotechnical Investigation	25,000
Surveying	10,000
Inspection	50,000
TOTAL	$195,000
ESCALATION FOR 1 YEAR (7%)	$ 62,000
TOTAL PROJECT CAPITAL COSTS IN FY 85	$946,000

CHAPTER 9
ANALYSIS OF EXPECTED BENEFITS

As part of its procurement process, Bonneville Power Administration must demonstrate positive benefits for development projects to be funded under the aegis of the Northwest Power Planning and Conservation Act. BPA has stated that "each recommendation, prior to implementation, requires a benefit/cost analysis" to relate the project cost to "the expected adult contribution to the sport and commercial fishery." In addition, it is necessary for development projects to "be based on, and supported by, the best available scientific knowledge." The objective of this benefits analysis is, therefore, to put the decision of whether or not to implement passage improvement at Dryden and Tumwater Dams into a rational, supportable perspective.

In order to satisfy these requirements, expected benefits of passage improvement were examined in two ways. The first was an analysis of available adult return data. These data included fish passage counts at Rock Island, Rocky Reach and Tumwater Falls Dams, redd and spawner counts made within the Wenatchee Basin, hatchery return figures and sport harvest information. The second was a consideration of the implications of passage improvement for stock vigor. Due to the nature of available information, the former yielded a quantitative estimate of benefits while the latter gave qualitative implications of improved passage. This is not to suggest that the latter perspective is less important or profound: on the contrary, with wild and naturally spawning stocks threatened throughout the Columbia and Snake River systems, stock vigor may be of paramount concern.

QUANTITATIVE ANALYSIS

The methodology and assumptions used to determine expected benefits of upgrading anadromous fish passage at Dryden and Tumwater Falls dams were developed in consideration of the quality and quantity of available information and the prevailing conditions in the Wenatchee system, and at the two dams. The methodology and assumptions should not be construed as having general applicability to other facilities where design and operational circumstances, watershed conditions, run characteristics and available data would be significantly different.

Passage data, redd and spawner counts, harvest estimates and hatchery return data were available on three stocks of Pacific Salmon found in the Wenatchee River system. These stocks are spring chinook, summer chinook and sockeye salmon. In addition, some run size data and management strategy information were available for steelhead trout. Upon careful assessment of data it became clear that the information was not sufficient to perform a rigorous and precise assessment of actual impairment of passage or reproductive success directly attributable to each of the two dams. The information was sufficient, however, for the development of a rational algorithm which provides a quantitative perspective on expected benefits through reduced impairment of passage and reproductive success.

It cannot be over-emphasized that data used for these analyses are subject to a great deal of error from several sources and that results must, therefore, be used with caution. In particular, counts of fish passing Columbia River dams which were used to determine approximate Wenatchee River run sizes are probably much more accurate and certainly more complete than counts made at Tumwater Falls Dam. Estimates of spawning escapement based on peak counts are less accurate still and are based on assumptions which could not be verified. Extrapolations of spawner escape-

ments from redd count data are dependent upon other assumptions and border on being subjective estimates. It should be noted that the use to which these data are put are not those for which the data were intended when gathered. For these reasons great conservatism was used in developing a prediction of project benefits.

SPRING CHINOOK

Estimates of present effects of passage difficulties at Tumwater Falls and Dryden dams were calculated from data spanning eleven years, from 1972 through 1982. The Wenatchee River run size for each year was estimated by computing the difference between Rock Island Dam counts (below the Wenatchee and Columbia Rivers confluence) and Rocky Reach Dam counts (above the Wenatchee and Columbia Rivers confluence). Some unexplained discrepancies in counts of adult spring chinook migrants typically occur between the Columbia River dams. These discrepancies are usually in the form of lower than expected counts at the upriver dam. There are several potential contributing factors to these unexplained differences, including differential fallback and double counting artifacts, illegal gillnetting or poaching and associated delayed mortality, and inherent variability in fish count data. For these reasons, the run size estimates were reduced by applying half the percentage loss observed each year between Priest Rapids and Rock Island Dams to the Rock Island count, and then subtracting the result from the run size estimate. It should be noted that the reach between Priest Rapids Dam and Rock Island Dam has no significant spawning tributaries, but has another dam, Wanapum Dam, within it. The reduction applied to the Rock Island Count averaged about seven percent. Over the eleven years of record, the calculated Wenatchee River spring chinook salmon run ranged from 2,526 in 1975 to 12,460 in 1978 with an average of 5,643 fish.

Spring chinook redd counts were conducted by Washington Department of Fisheries (WDF) personnel in index reaches in streams tributary to the Wenatchee, both between Dryden and Tumwater Falls dams (including Icicle Creek), and above Tumwater Falls Dam. Chelan County PUD has also conducted redd surveys for the past three years encompassing nearly all spring chinook spawning habitat in streams containing WDF index reaches. In addition, hatchery return data are available along with Icicle Creek sport harvest estimates based on punch-card returns.

Estimates of numbers of escaped fish were derived by applying two correction factors to redd counts. One factor is an assumed number of fish per redd. The other is the proportion of redds dug in a particular year that were actually observed during the surveys. In the past, two different multipliers for fish per redd have been used by WDF for estimating run size. One is a 2.14 multiplier derived from data gathered on spring chinook in the Yakima River Basin (Easterbrooks 1983) and assumed to apply reasonably well to the Wenatchee River stock. The other was a 3.1 multiplier derived for summer chinook in the Methow River, a tributary of the Columbia River north of the Wenatchee drainage. The 2.14 multiplier was chosen for use in this analysis for two reasons. First, it was derived for a more similar stock (spring chinook as opposed to summer chinook), although in a different and much larger basin. Second, use of the 3.1 multiplier along with other factors discussed below would lead to escapement estimates exceeding total run estimates based on Columbia River dam count differentials for a significant number of years.

The factor which corrects for unobserved redds was derived through a comparison of WDF and Chelan County PUD counts for the last three years. As stated earlier, the Chelan County PUD surveys covered all or nearly all known spring chinook spawning

habitat in the streams containing WDF index areas. Over the last three years, the WDF surveyors have counted approximately 65 percent of the number of redds counted by Chelan PUD surveyors. It is reasonable to assume that some redds in the Wenatchee system escaped detection by the Chelan County PUD surveyors due to oversight, spawning after completion of the surveys, spawning outside count areas and occasionally poor surveying conditions. Therefore, the assumed percentage of spring chinook redds in the Wenatchee Basin typically observed by WDF surveyors was reduced to 60 percent for this analysis. With these factors, numbers of spawning fish were estimated by multiplying the redd counts by 2.14 fish per redd and dividing that product by 0.60 to account for unseen redds.

Using this algorithm, estimates of the number of fish spawning in streams tributary to the Wenatchee between Dryden and Tumwater Falls dams and above Tumwater Falls Dam were calculated for each year of record. From these annual estimates, the percentage of each year's run spawning in tributary streams between dams and in streams above Tumwatr Falls Dam can be calculated. The percent of each year's run harvested in Icicle Creek or returning to the Leavenworth National Fish Hatchery was also calculated. Combining estimates of "between dam" spawners with hatchery return data and harvest estimates yielded estimates of the total number of fish accounted for between the two dams, along with a percentage of each year's run thus accounted for. It was found that for the 11 years considered, the proportion of the total spring chinook run, including hatchery returns, accounted for above Tumwater Falls Dam averaged 36 percent, and that the proportion of the total estimated run accounted for between the dams averaged 41 percent. Variability in the values does not appear to be related to hydraulic conditions or other known physical conditions in the river during the migration period. Part of the "between dam"

variability is due to the increase in Leavenworth Hatchery return rate after 1975.

Application of the average proportion of the run spawning or accounted for in each portion of the drainage, between dams or above Tumwater Falls Dam, to the average estimated run size for the 11 years of record was felt to produce the most reliable indication of long-term trends in spawner population distribution. Application of the average distribution percentages to the average run size produces a "hypothetical average run," which provides 2,003 fish above Tumwater Dam and 2,330 fish "between" Dryden and Tumwater Falls dams. In order to proceed with the calculations, it is necessary to incorporate information on the relative effects of the two dams and other factors on fish passage or reproductive success. Since such information is not available, it was assumed that the effects of both dams on migrating fish passing through each reach of the stream are equal. Using this assumption and the estimated distribution of the average hypothetical run derived above, the "success rate" for passage through each reach was determined algebraically.

The success rate for passage of spring chinook salmon through each reach was determined to be approximately 0.84. This success rate was then applied to the derived run and escapement estimates, and losses through each reach were determined. It should be noted at this point that this "success rate" should not imply a "failure rate" which can be attributable to the existing dams and fish pass facilities alone. These calculations, due to lack of data, could not take into account sources of error that may lead to over-estimates of impairment of passage or reproductive success due to facilities. Potential sources of error include the somewhat low multiplier of 2.14 fish per redd, possible underestimates of fish harvested based on punch-card return data, mortality due to poaching, predation, harassment, disease, etc.

It should be noted that some losses, including harassment, disease, poaching and exhaustion, are probably exacerbated by passage problems. However, losses associated with hooking, natural predation and some harassment, are not. It was reasoned that somewhere between 50 percent and 75 percent of the unaccounted "losses" of adult fish available to the Wenatchee River could be attributed to these other factors. In order to be conservative in estimating losses attributable to the two dams, the calculated impairment for the hypothetical average run were reduced proportionately. The resulting range of adjusted estimates for each dam are given in Table 3 by spawning group.

Table 3.--Range of Estimates of Impairment of Spring Chinook Salmon Due to Tumwater Falls and Dryden Dam

	Between Dam Spawners	Hatchery Fish, Sport Harvest	Above Tumwater Dam Spawners
Dryden Dam	18-35	96-192	117-233
Tumwater Falls			98-195

Another potential effect of improving passage conditions at the two dams is an eventual shift of spawning activity in an upstream direction, thereby enabling offspring to occupy more of the available rearing habitat in the system. This would occur if impairment of passage or reproductive success were reduced by modern, effective fish passage facilities. The upstream portion of the stock would not be selected against as much as it is under existing conditions and should show a proportionate expansion. Although the improved passage could have some positive influence on this recruitment, it is impossible to quantify. In addition, improved passage at Dryden Dam could result in higher escapement of adult fish to Leavenworth Hatchery in years with low spring flows which currently impair passage of spring chinook stock.

SUMMER CHINOOK

Estimates of summer chinook salmon losses through each reach under present passage conditions were derived in much the same way as those for the spring chinook stock. Differences in the data base and differences in the distribution of spawning populations in the river required some adjustment in the details of the analysis.

Summer chinook spawn in the mainstem Wenatchee River below Dryden Dam, between Dryden and Tumwater Falls dams and above Tumwater Falls Dam. Like spring chinook, summer chinook run size estimates were calculated by subtracting Rocky Reach Dam counts from Rock Island Dam counts. Since there was no consistent pattern of unexplained discrepancies in counts between Priest Rapids and Rock Island Dams, count differentials were not adjusted.

Separate aerial redd surveys have been conducted by WDF and Chelan County PUD for many years. Data used for this analysis include the ten years from 1973 through 1982: data from these years were judged to be the most reliable and consistent. Redd count data were summarized for spawning populations below Dryden Dam, between Dryden and Tumwater Falls dams and above Tumwater Falls Dam. This was done by combining the two surveys made each year to determine a "peak" redd count for each section. WDF estimates that they observe about 85 percent of the redds present during their annual survey (Easterbrooks, pers. comm.). Lacking better information, the "peak" counts were adjusted for unseen redds by dividing them by 0.85. The Department also assumed a multiplier of 3.1 fish per redd. This multiplier was developed for a similar stock, summer chinook, in the nearby Methow River watershed (Meekin and Weinhold 1966, Meekin 1967).

It was estimated from Columbia River dam counts that the total summer chinook run up the Wenatchee River ranged from 3,841 in 1974 to 10,680 in 1978 with an average of 6,874 fish for the ten years of record studied. It was further determined that an average of approximately 24 percent of the runs available to the system spawned successfully below Dryden Dam, that an average of about 51 percent of the runs spawned successfully between Dryden and Tumwater Falls dams, and that an average of about 6 percent of the runs spawned successfully above Tumwater Falls Dam.

Using the same algorithm developed for the spring chinook stock, again assuming that the two dams have equal effects upon fish moving upstream, it was determined that of the hypothetical average summer chinook run, 1,615 fish spawn below Dryden Dam, 3,526 spawn between dams, and 406 fish spawn above Tumwater Falls Dam. The calculated success rate for passage through each reach was 0.77. This rate was applied to the hypothetical run size and spawner number estimates to calculate passage or reproductive impairment at each dam. This analysis, like the one performed for spring chinook, does not consider potential sources of error which may lead to an overestimate of dam-caused impairment. These sources of potential error include assumptions relating to the percent of all redds seen by aerial surveyors, the fish per redd factor, and mortalities due to accidental hooking by steelhead fishermen and associated reproductive impairment or delayed mortality, poaching, predation, harassment, and disease. As mentioned earlier, some losses, including harassment, disease, poaching and exhaustion, may be exacerbated by passage problems. However, losses associated with hooking, natural predation and some harassment, are not. Again, it was reasoned that between 50 percent and 75 percent of the unaccounted "losses" of adult fish available to the Wenatchee River could be attributed to these other factors and in order to be conservative the

calculated impairment estimates were reduced proportionately. The resulting range of adjusted estimates for each dam are given in Table 4 by spawning group.

Table 4. --Range of Estimates of Impairment of Summer Chinook Salmon Due to Tumwater Falls and Dryden Dam

	Between Dam Spawners	Above Tumwater Dam Spawners
Dryden Dam	263-525	39-78
Tumwater Falls		30-60

Improved passage conditions at Tumwater Falls and Dryden Dams could result in a shift or expansion of spawning activity upstream for summer chinook, for the same reasons discussed for spring chinook. A trend in this direction has already been noted since power production at Dryden ceased. Such a shift could have some positive effect on recruitment of this stock since the juvenile population could take advantage of more rearing habitat. It should be noted that rearing habitat is not thought to be limited for this stock in the Wenatchee system at this time.

SOCKEYE

Data on sockeye salmon are different in several respects from those available for spring and summer chinook stocks. Wenatchee River run sizes for recent years from 1973 through 1982 were computed in the same way as spring and summer chinook run sizes. No pattern was evident in the data which would warrant reduction in numbers to compensate for unaccounted losses between Columbia River dams. For the 10 years of record, the calculated run averaged 22,009 fish and ranged from 6,592 in 1978 to 64,613 in 1977. During the four years between 1964 and 1967, there were

coincident sockeye counts made at Rock Island, Rocky Reach, and Tumwater Falls dams. This gives the opportunity to directly assess passage success at Tumwater Falls and Dryden dams. For those four years, passage counts at Tumwater Falls Dam accounted for an average of 102 percent of the available run as determined by the Columbia River dam counts. For these years at least, the data suggest that, although some delays may have been experienced, fish were not prevented from reaching their spawning grounds near Wenatchee Lake to any significant degree.

This should not be construed as meaning that no impairment of passage or reproductive success is occurring under present conditions. Over the 16-20 years since these data were obtained, the existing passage facilities have deteriorated significantly and have not always been operated under optimum conditions. Significant excess expenditures of energy reserves and overcrowding in the Tumwater Falls ladder could be leading to reduced spawning success and egg and alevin survival. On the other hand, sockeye are less susceptible to certain factors which reduce chinook escapements, including illegal gillnetting, poaching, harrassment and incidental hooking by sport fishermen. It should be noted that the Tumwater Falls ladder, if properly adjusted, operates best during these river flow conditions which typically accompany the sockeye run.

For eight years from 1954 through 1957, 1959, and 1965 through 1967, both peak spawner and complete Tumwater Falls Dam counts were made. An attempt was made to establish a consistent correlation between these two figures. The data, however, did not lend itself to this and no correlation was found. It cannot be concluded from existing data that facilities at either Dryden Dam or Tumwater Falls Dam are preventing passage of significant numbers of sockeye salmon, at least when adjusted properly.

There is another aspect of the sockeye salmon stocks in the Wenatchee River drainage that warrants consideration. Work conducted and compiled by James Mullan of the Fisheries Assistance Office of the U.S. Fish & Wildlife Service indicates strongly that the environmental conditions in Wenatchee Lake (cold, deep, oligotrophic, with short retention time) turbine mortality, harvest management strategies, and other factors not related to passage at Dryden and Tumwater Falls dams, are primarily responsible for limiting production of sockeye salmon in the drainage, often independently of escapement. This is not to say delay, injury and increased consumption of energy reserves, possibly caused by the two dams, may not effect the sockeye run. This point will be covered briefly later.

STEELHEAD

The available data on steelhead trout in the Wenatchee Basin does not permit a quantitative analysis of the kind performed on the three salmon stocks. Essentially, only approximate run size and approximate harvest data are available. Until 1983, an average annual run of about 2,000 steelhead ascended the Wenatchee River, of which 30 to 50 percent has been harvested. Although spot observations of adult steelhead having difficulty finding existing passage structures have been made, no redd or spawner counts have been made which could lead to calculation of a rate of successful passage at either or both dams. Because no data exist from which supportable estimates can be derived, assumptions have been made by Washington Department of Game (WDG) biologists relating to an "effective rate of impairment" of spawning success attributable to both dams (Tony Eldred, pers. comm.). This rate of impairment is estimated by WDG to be about 20 percent. Under recent conditions, therefore, with spawning escapements at about 1,000 to 1,400 fish, between 200 and 280 fish may have been effectively lost due to the two facilities.

A new management strategy is presently being implemented by WDG which has profound implications for this analysis. An aggressive program to rebuild stocks to a run size of 10,000 fish is under way. As part of this program, harvest will be cut to about 20 percent of the run and kept there until the goal of about 10,000 fish is reached. Once the goal is reached, sport harvest will be increased until the actual escaped spawner count is 3,000 fish. The department is confident the run target can be realized in the relatively near future. As discussed in Chapter 6, the 1983 steelhead run was estimated to be about 8,000 fish, probably as a result of the excellent water year, which will undoubtedly serve to accelerate recovery of this stock. Further assistance in recovery will probably be provided by the three-year cooperative pilot program for releasing Skamania stock juveniles into the system, especially if it is extended. It is reasonable, therefore, to use the 8,000 fish escapement figure as a base for estimating benefits.

If the Washington Department of Game's estimate of 20 percent impairment is realistic, this would mean an effective "loss" of about 600 escaped adult spawners. Insufficient information is available to partition this "loss" between the two dams. In order to be conservative, this analysis will assume a 10 percent impairment or a "loss" directly attributable to passage difficulties of about 300 adult spawners. Note that this "loss" estimate was derived for future benefits and does not represent present losses at the structures.

ECONOMIC ANALYSIS

Based on the quantitative analyses of impairment of adult anadromous fish at Dryden and Tumwater Falls dams, the approximate economic implications of passage losses can be determined. Meyer

(1982) calculated net economic values for escaped salmon and steelhead spawners in the Columbia River system. An escaped spawner is an unharvested adult fish which completes its upstream migration and spawns. In that capacity, an escaped spawner represents an increment of the "capital assets" of the stock of fish to which it belongs. It is therefore much more valuable than any harvested fish, since it bears the burden of future production. Although Meyer's values are averages for the system as a whole and may not reflect certain local differences in productive capacities and survival rates of individual stocks, they should give an approximate dollar value for fish losses of the magnitude estimated here. Meyer assigns values of $550 per escaped spawner for both spring and summer chinook salmon, $18 per escaped spawner for sockeye salmon and $359 per escaped spawner for steelhead trout. Washington Department of Fisheries, among others, has expressed the position that Meyer's values for salmon are somewhat high as a result of certain technical factors and assumptions used in his analysis. A recent attempt by National Marine Fisheries Service, who sponsored Meyer's work, to adjust the values resulted in still more technical concerns, but no clear resolution of the problems. The Service has elected to continue to promulgate the original values temporarily until a workshop on anadromous fish valuation, scheduled for May of 1984, produces new values or recommends further research and analysis. This analysis will use the original Meyer values for salmon, since no others have yet been officially adopted by NMFS. The dollar value for steelhead trout has recently been revised downward to $270 per escaped spawner (pers. comm., Tony Eldred). This value is used here. Multiplying these values by the estimated adult fish "losses" gives the approximate economic losses represented by passage problems at the two dams. These economic losses are summarized in Table 5. The estimated annual benefits of new facilities are $391,000 to $701,000.

Table 5.--Ranges of Estimated Annual Economic Losses Attributable to Tumwater Falls and Dryden Dam

	Spring Chinook	Summer Chinook	Steelhead Trout
Dryden Dam	$75,000-$150,000	$165,000-$330,000	$81,000 (both dams)
Tumwater Falls	$55,000-$110,000	$15,000-$30,000	

TOTAL ANNUAL BENEFITS: $391,000 to $701,000

It should be pointed out that losses of hatchery and sport caught spring chinook salmon were not included in this economic analysis. Further, this analysis does not assume that run strength, the number of adult fish available to run up the Wenatchee River, would increase as a result of improved passage conditions at Dryden and Tumwater Falls Dams. With progressive harvest management significant increases would probably occur and thus increase benefits proportionately.

Benefits discussed in this section, along with costs discussed in Chapter 8, were used in a benefit/cost analysis. The benefit/cost analysis is presented in Chapter 10.

STOCK VIGOR

Passage improvement at Tumwater Falls and Dryden dams should be considered from a perspective other than simply estimating numbers of fish lost each year and assigning dollar values for lost production. The view of escaped spawners as capital assets referred to above is an extremely important one to take. This view has been stressed repeatedly by James Mullan of the U.S.

Fish and Wildlife Service at the Leavenworth National Fish Hatchery. It is his position that preservation and protection of these capital assets is the first priority of responsible resource management. Mullan has indicated that, if properly operated, fish passage facilities at Dryden and Tumwater Falls dams do not pose a great direct threat to anadromous fish runs in reasonably good water years. However, recurrent drought conditions, not uncommon in North Central Washington, could precipitate catastrophic depletion of the capital assets represented by anadromous fish escapements to levels from which recovery would be difficult indeed.

In a broader sense, the concept of stock vigor, although difficult to express in monetary terms, is extremely important. The vigor or health of a stock of anadromous fish has tremendous implications for its future, especially in the face of unforeseen adversity. It is the nature of interactive biological systems to defy the convenient segregation of "causes" relative to what occurs inside them. Virtually every major change in such a system influences the relationships among its components. A healthy biological system will respond to major perturbations by calling upon its biological reserves to help balance itself. The reserves or flexibility of a biological system to withstand major perturbations is often a function of the cumulative stresses faced by populations making up the system. The less "adversity" a population encounters under normal circumstances, the better able it is to respond to major perturbations, either natural or man-caused. When biological reserves of a system are taxed to the limit just to maintain the status quo under normal conditions, the system loses its flexibility and is in great danger of collapse from disturbances that might otherwise have a relatively minor impact. Once collapsed the system may take a very long time to recover, even if the proximal cause of the collapse is removed. This is especially true if the system continues to be

"stressed" by other conditions. The passage conditions at Dryden and Tumwater Falls dams are an excellent example of the kind of influences which could facilitate a population collapse due to some unfortunate and/or unforeseen combination of environmental or biological conditions. Impaired passage could also certainly delay recovery if such a collapse occurred. Mullan has pointed out that for nearly 40 years, prior to 1957, when the Dryden Hydroelectric Project was in operation, the lack of suitable fish passage provided by existing facilities at Dryden Dam was a major limiting factor for fish production at the Leavenworth Hatchery, and that those summer flows for fish passage were similar to those which could be expected in a severe drought. From this perspective alone, economic implications of present conditions aside, rectification of passage conditions at both Tumwater Falls and Dryden dams can and should be justified.

In all fairness, it should be pointed out that there are many other factors which work toward excessive depletion of anadromous fish stocks. These include over harvest, the mixed stock fishery problem, illegal gillnetting and poaching, incidental hooking and associated latent mortality and exhaustion of energy reserves, harrassment and habitat depletion. There are many political, economic, social and natural constraints which appear to put the solutions of these problems beyond our immediate grasp. Upgrading fish passage is, however, one thing we can do something about which will produce sound immediate benefits and provide some relief to a strained system. As solutions to other problems surrounding management of anadromous fish resources evolve in the future, the immediate benefits of upgrading fish passage will continue to expand proportionately.

CHAPTER 10
BENEFIT/COST ANALYSIS

To evaluate the economic feasibility of a project, the benefits must be compared with the costs. This is accomplished with a benefit/cost analysis, a ratio of project benefits to project costs. If the benefit/cost ratio (B/C) is greater than 1.0, the project can be economically justified.

A Benefit/Cost analysis was performed for the Tumwater Falls and Dryden Dam Project by placing project benefits and costs on a consistent basis, i.e., present value, and determining the B/C ratio. The following sections present the assumptions and details of the analysis.

ASSUMPTIONS

Four key assumptions were made in this analysis which included:

- 50-year Project Life
- 11% Borrowing Rate
- 7% Inflation Rate
- 4% Discount Rate

The assumption of a 4% discount rate deserves some explanation. The discount rate should be thought of as the long-term cost of borrowed money, or the cost of money which has the risk associated with inflation removed from it.

BENEFITS

Annual economic benefits resulting from the proposed fishway projects presented in Chapter 9 were between $391,000 and $701,000. Since benefits would accrue from the first year and continue throughout the assumed 50-year project life, the present value of benefits are calculated below for the "low" and "high" benefit figures estimates. These are calculated using a Present Worth factor, P/A, and a 50-year project life and a 4% discount rate. This is calculated with the equation:

$$\frac{(1+i)^n - 1}{i(1+i)^n}$$

where: n = number of years
i = discount rate

PV = $391,000 x (P/A, 4%, 50-yr)

= $391,000 x 21.482

= $8,400,000

or,

PV = $701,000 x (P/A, 4%, 50-yr)

= $701,000 x 21.482

= $15,059,000

COSTS

As discussed in Chapter 8, the costs of fishway facilities include the capital costs of construction and engineering services and the annual costs of operation and maintenance. Operation and maintenance costs will arise from regular visits to the facilities by Chelan County PUD maintenance staff. Chelan County PUD maintenance staff would be expected to clear trash racks, adjust auxiliary water flows, and perform other necessary maintenance of the project area.

Operation and maintenance is estimated to require two visits per week at one-half man day per visit. Labor is estimated to be $125/week. (This is based on one FTE at $30,00O/year, including benefits, working 240 days/year.) Travel is estimated at 50 miles round trip and two trips per week at $0.30/mile. Travel costs are then $30/week.

The present value of operation and maintenance costs is:

$$PV = (Labor/wk + Travel/wk) \times 52\ wk/yr \times (P/A, 4\%, 50\text{-yr})$$

$$= (\$125/wk + \$30/wk) \times 52\ wk/yr \times 21.482$$

$$= \$173,000$$

Capital costs of construction and engineering services, noted in Chapter 8, total $1,879,000 for both Tumwater Falls and Dryden Dam facilities.

The total present value of capital and annual costs is:

$$\text{Total Costs} = \$173,000 + \$1,879,000$$

$$= \$2,052,000$$

BENEFIT/COST RATIOS

The B/C ratios can now be determined by dividing the present value of benefits by the present value of costs. Two B/C ratios are shown below: they represent the "low" and "high" estimates of project benefits.

$$B/C = \$8,400,000/\$2,052,000$$

$$B/C = 4.1$$

and,

$$B/C = \$15,059,000/\$2,052,000$$

$$B/C = 7.3$$

With B/C ratios between 4.1 and 7.3, the project is clearly justifiable from an economic point of view.

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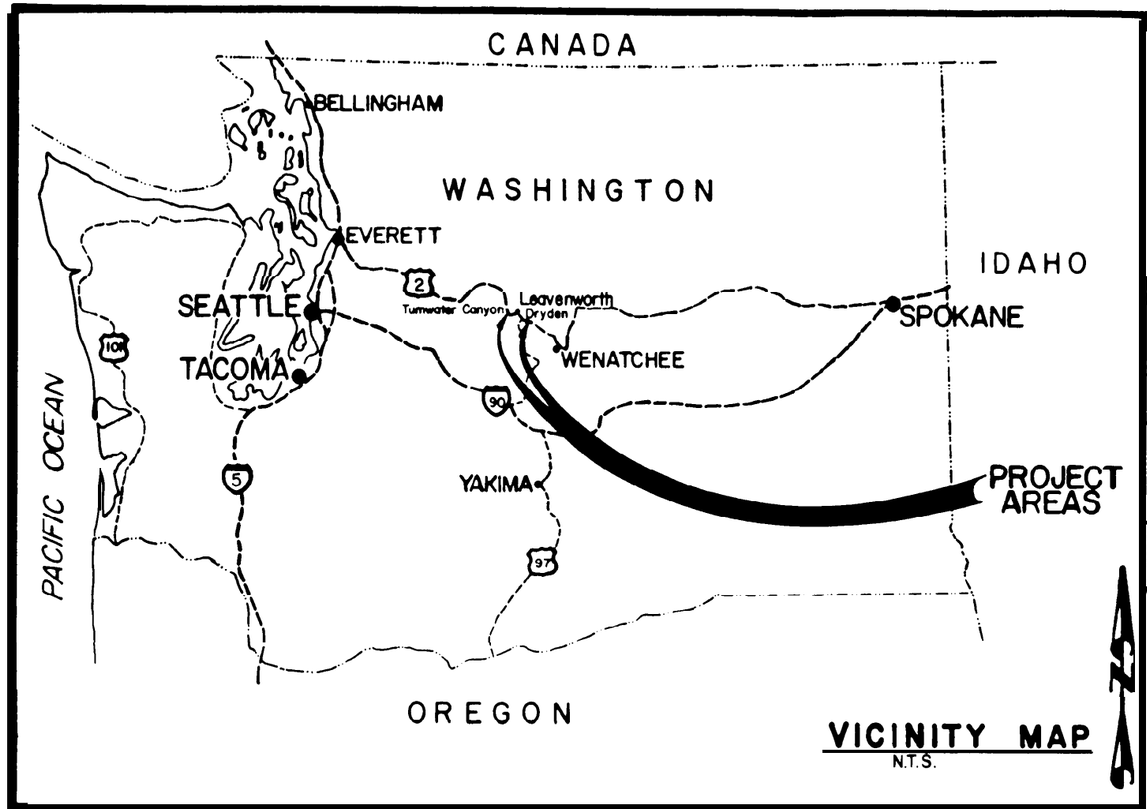
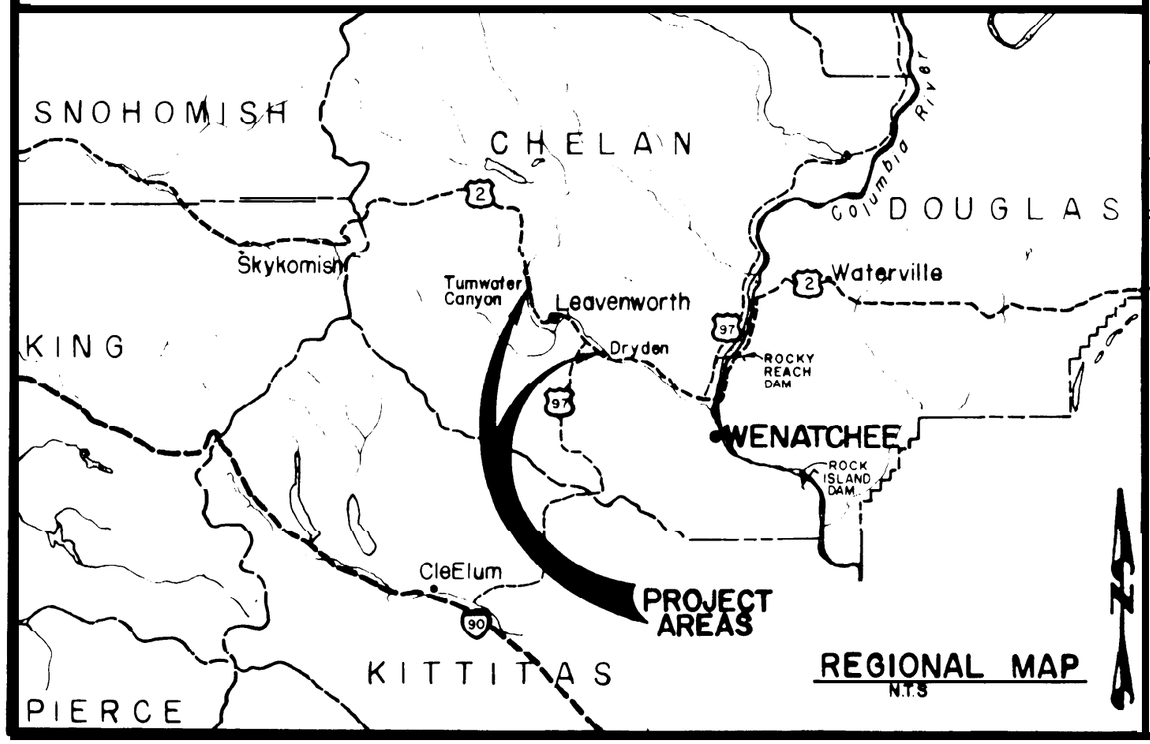
Purdom, R. 1983. Personal Communication from R. Eldridge, Ott Water Engineers to R. Purdom, Chelan County PUD, Wenatchee, WA. October 1983.

APPENDIX A

FIGURES





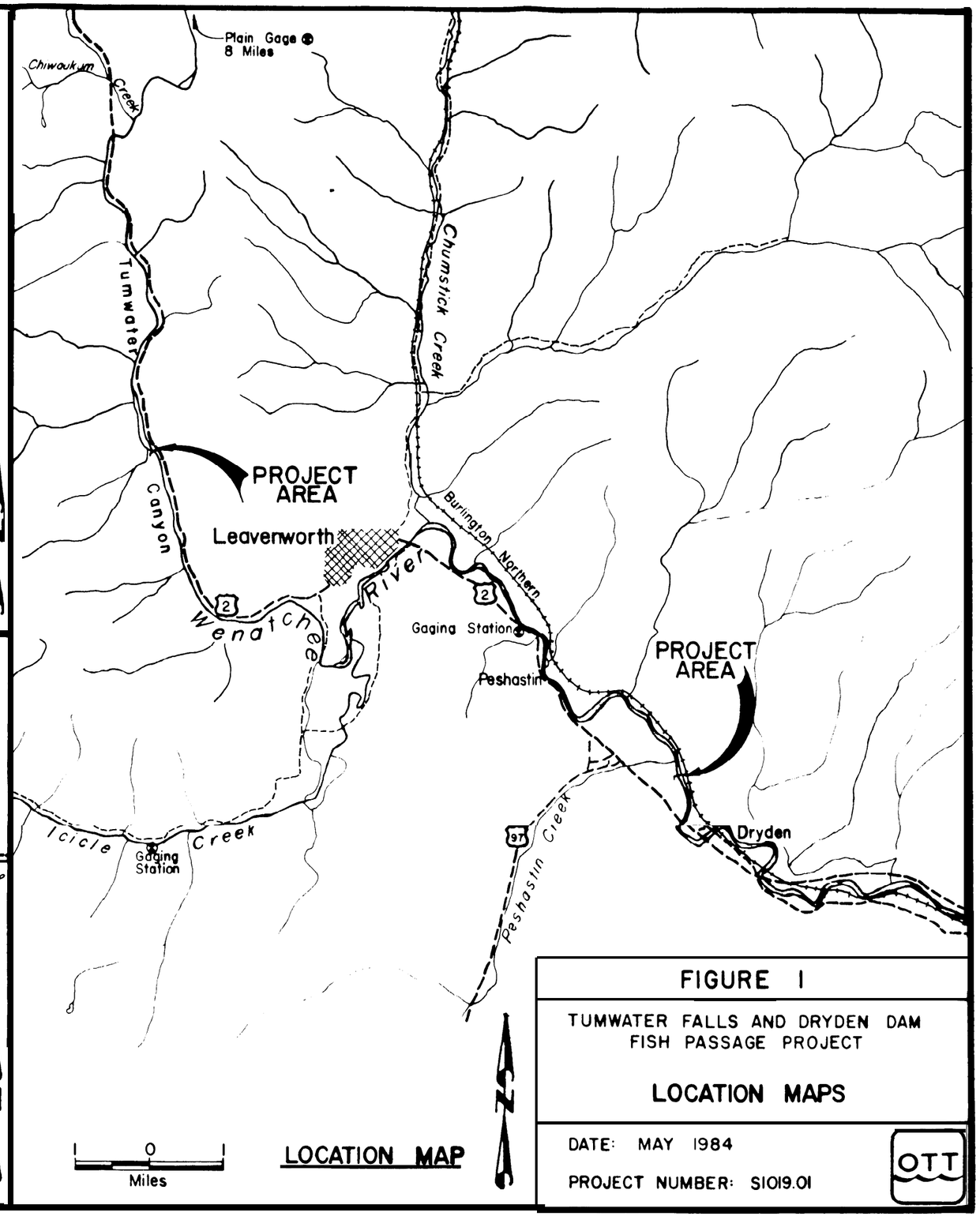


FIGURE 1

TUMWATER FALLS AND DRYDEN DAM
FISH PASSAGE PROJECT

LOCATION MAPS

DATE: MAY 1984

PROJECT NUMBER: S1019.01

OTT

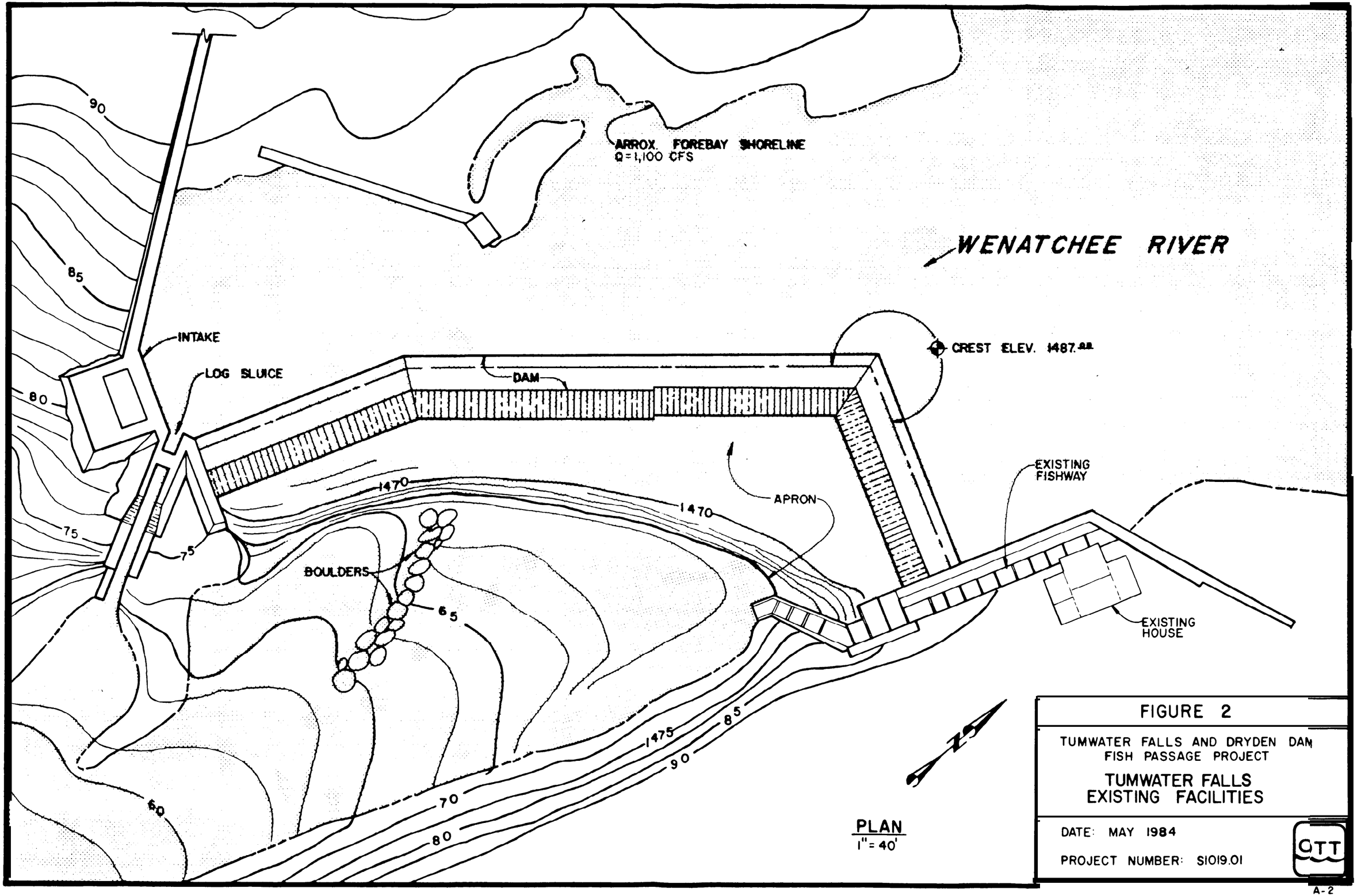


FIGURE 2

TUMWATER FALLS AND DRYDEN DAM FISH PASSAGE PROJECT

TUMWATER FALLS EXISTING FACILITIES

DATE: MAY 1984

PROJECT NUMBER: S1019.01

GTT

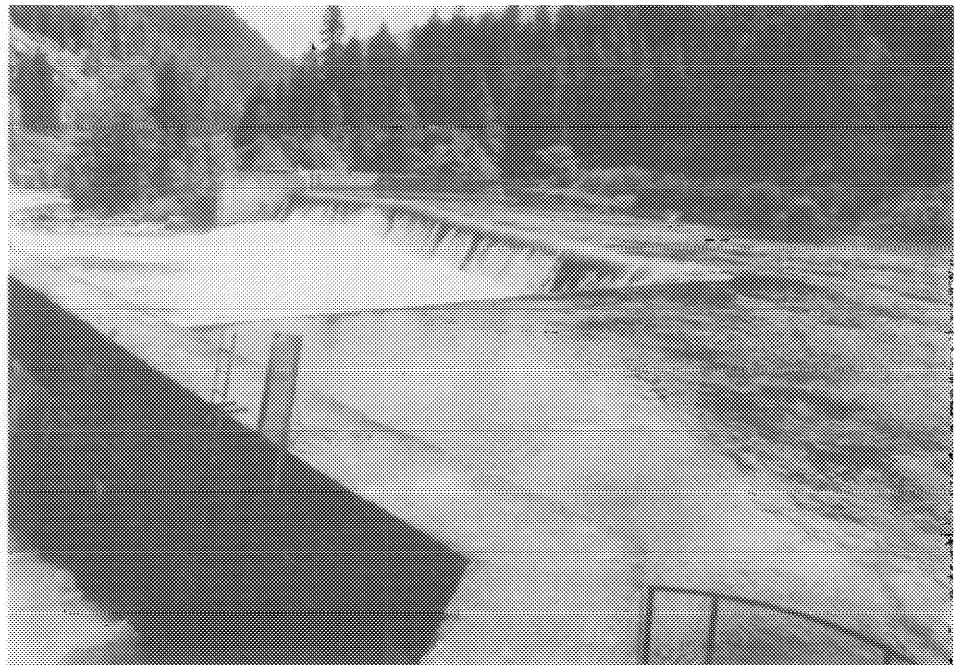
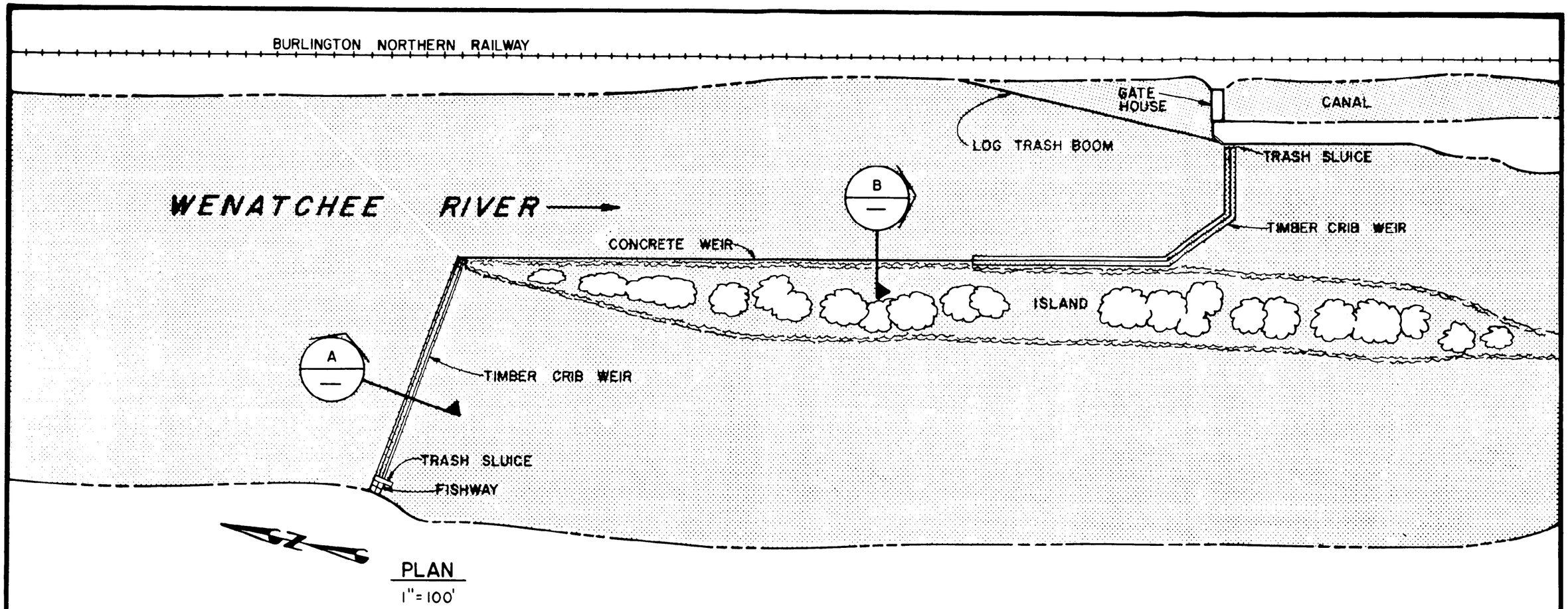
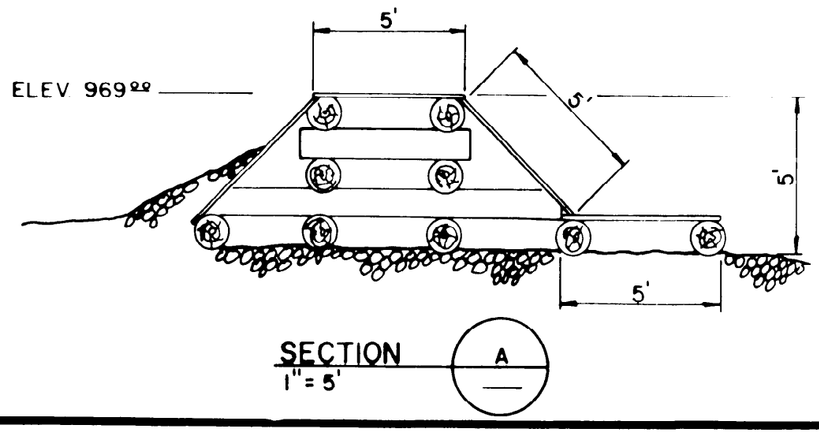


Figure 3.--Photograph of Tumwater Falls Dam looking Downstream.

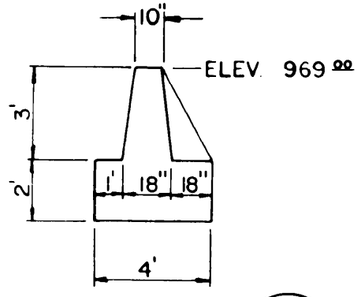
Figure 4.--Photograph of Tumwater Falls Dam taken from Left Bank.



PLAN
1" = 100'



SECTION A
1" = 5'



SECTION B
1" = 5'

FIGURE 5

TUMWATER FALLS AND DRYDEN DAM
FISH PASSAGE PROJECT

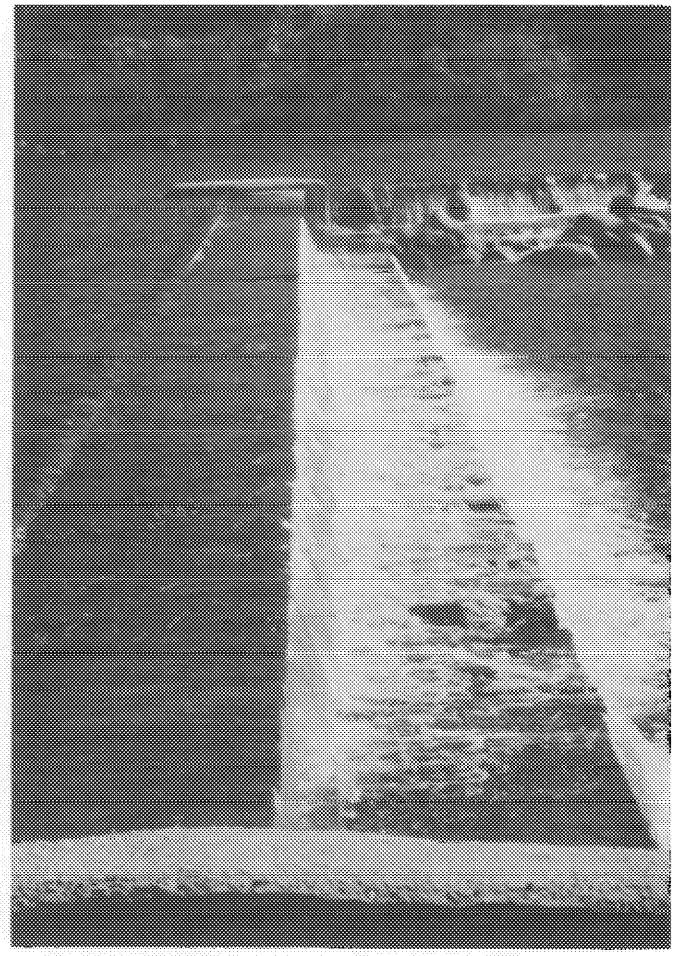
DRYDEN DAM
EXISTING FACILITIES

DATE: MAY 1984

PROJECT NUMBER: S1019.01

OTT

Figure 6.--Photograph at Dryden Dam showing the Upstream Timber Crib Section.



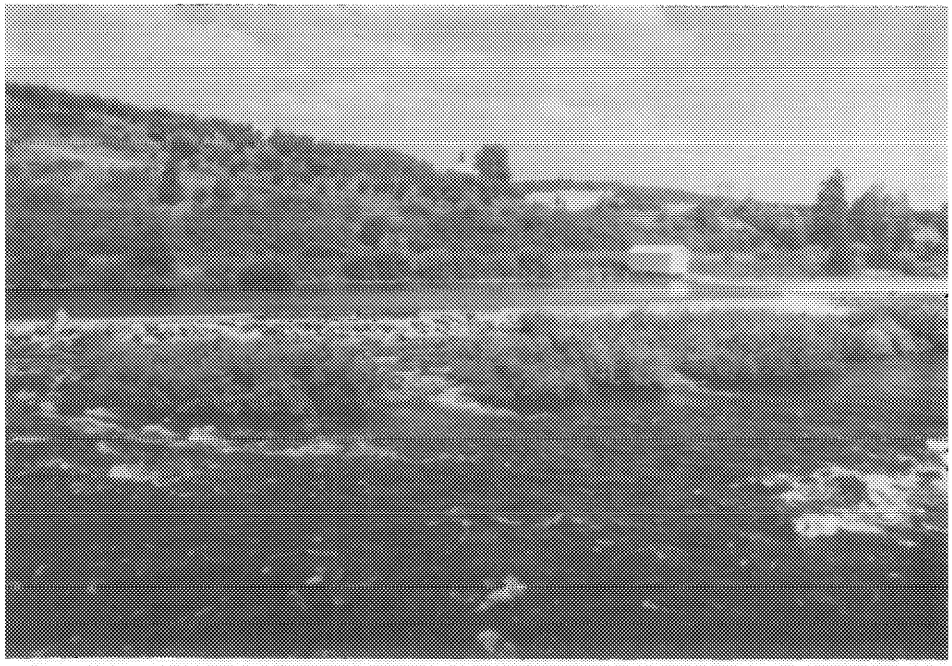
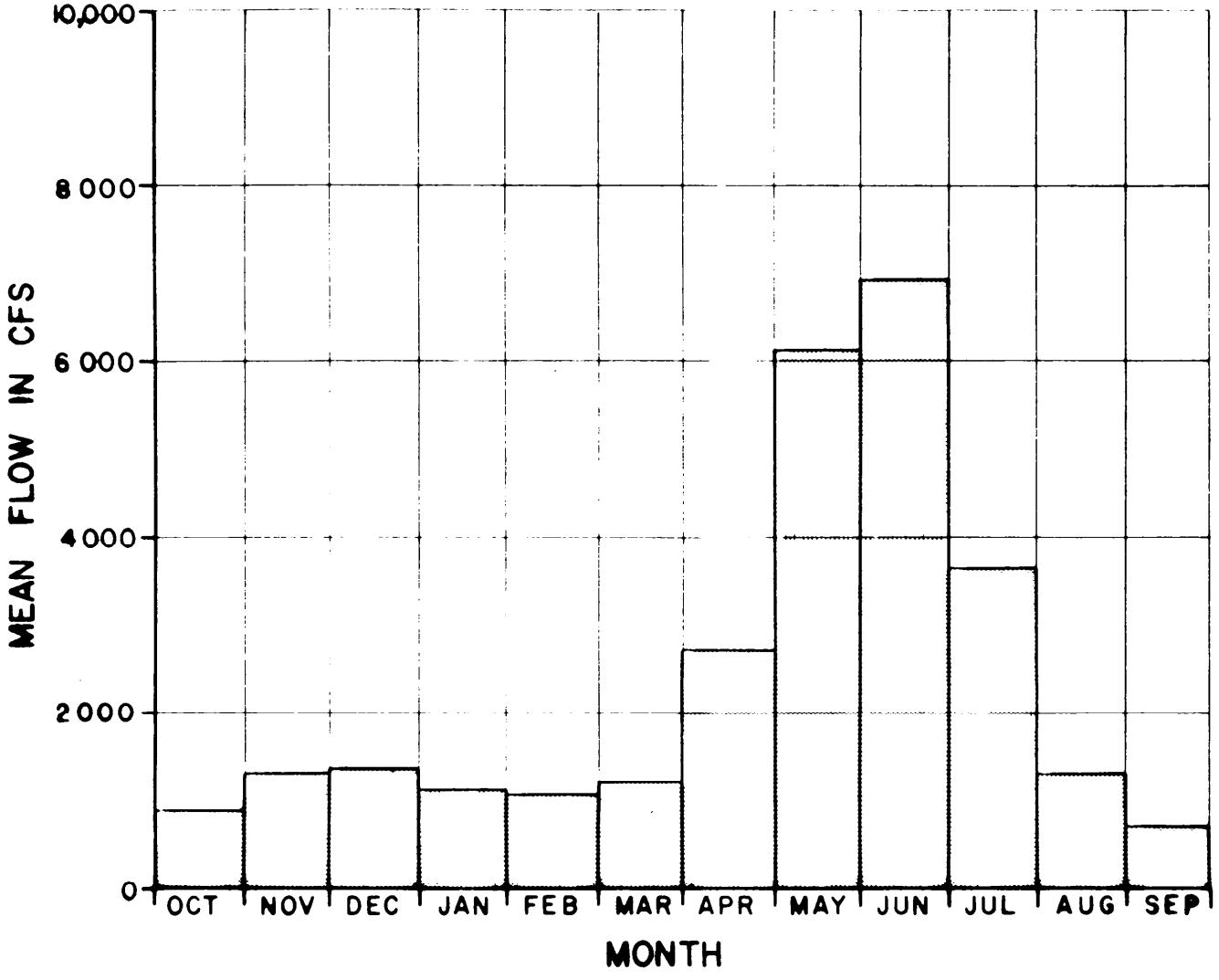


Figure 7.--Photograph at Dryden Dam showing the Concrete Weir Section.



NOTE: PLAIN GAGE DATA FROM 1911 TO 1974, ADJUSTED TO TUMWATER FALLS

FIGURE 8

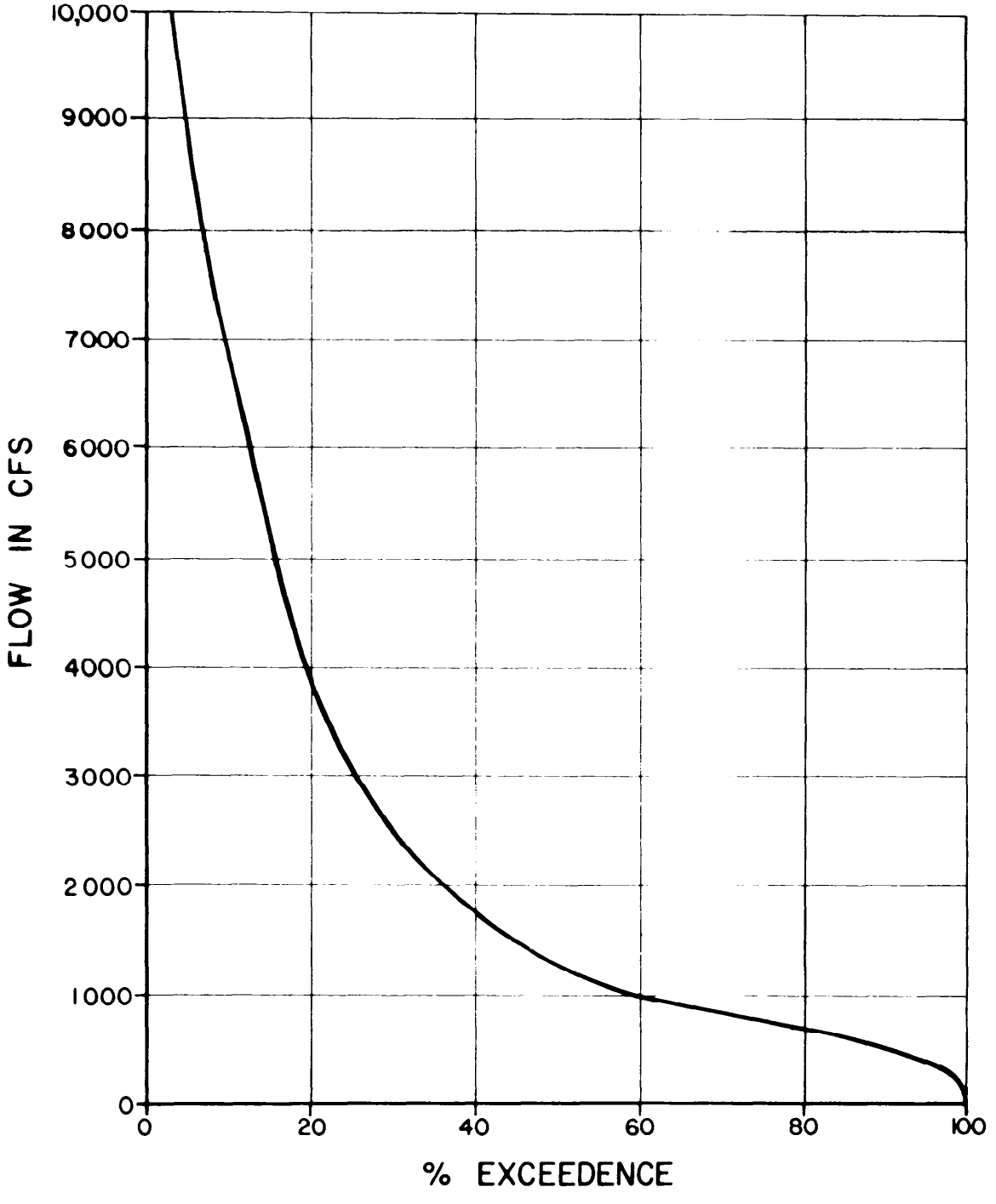
TUMWATER FALLS AND DRYDEN DAM FISH PASSAGE PROJECT

TUMWATER FALLS MEAN MONTHLY HYDROGRAPH

DATE: MAY 1984

JOB NUMBER: S1019.01

OTT



NOTE: PLAIN GAGE DATA FROM 1911 TO 1974, ADJUSTED TO TUMWATER FALLS

FIGURE 9

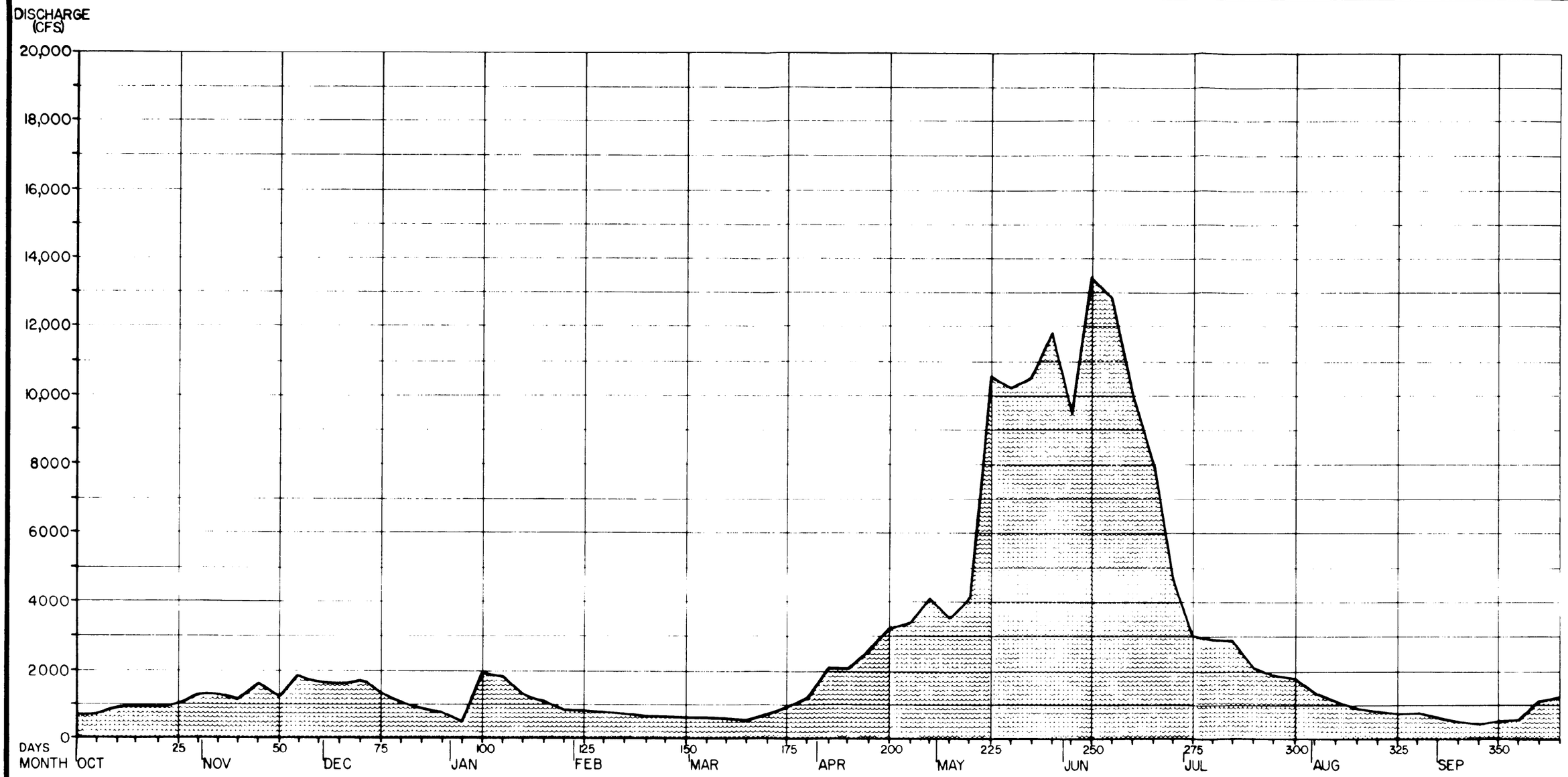
TUMWATER FALLS AND DRYDEN DAM
FISH PASSAGE PROJECT

TUMWATER FALLS FLOW DURATION CURVE

DATE: MAY 1984

JOB NUMBER: S1019.01

OTT



NOTE: WATER YEAR 1969, PLAIN GAGE DATA ADJUSTED TO TUMWATER FALLS

FIGURE 10

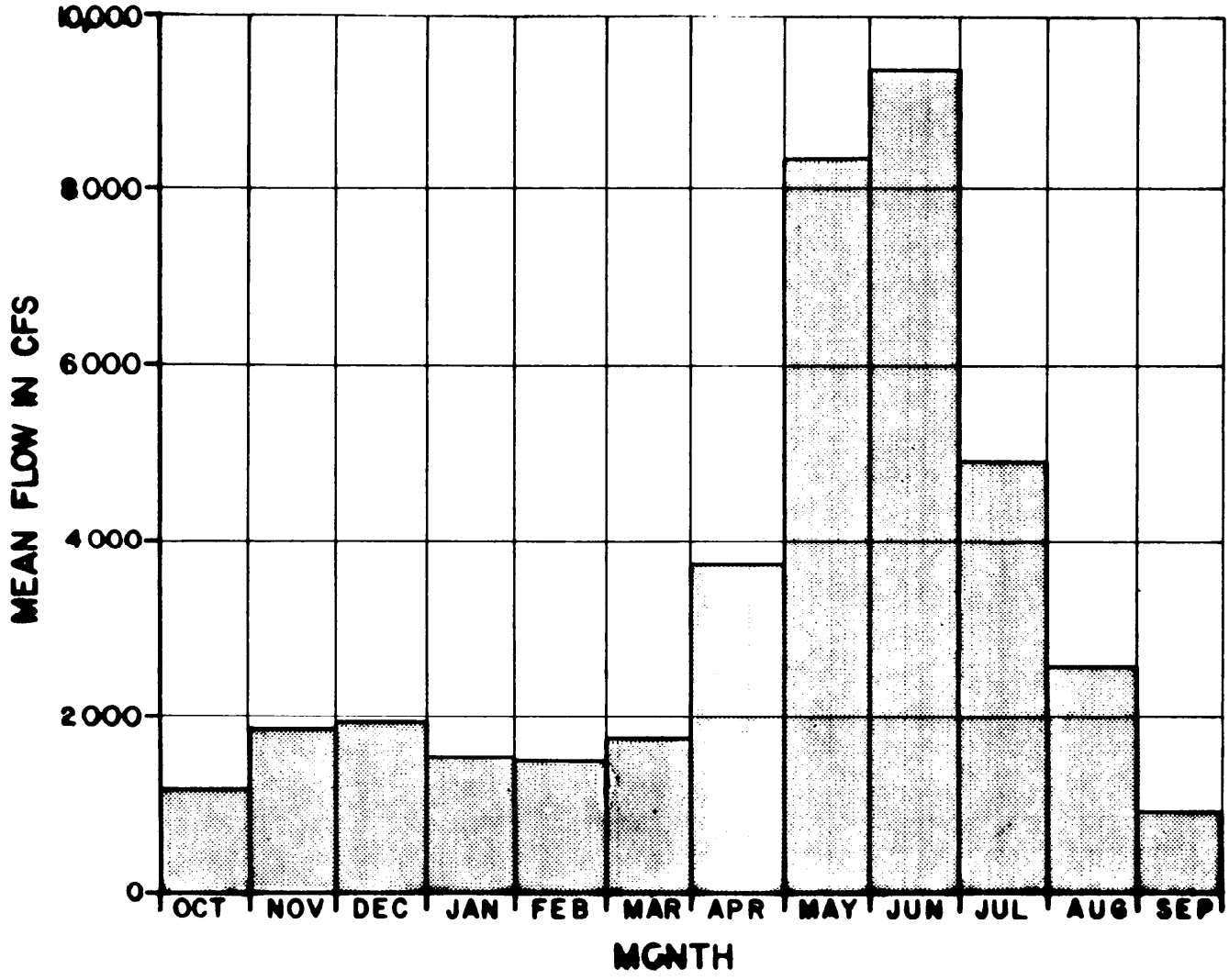
TUMWATER FALLS AND DRYDEN DAM
FISH PASSAGE PROJECT

TYPICAL WATER YEAR AT TUMWATER FALLS

DATE: MAY 1984

PROJECT NUMBER: S1019.01

OTT



NOTE: PESHASTIN GAGE DATA FROM 1930 TO 1981, ADJUSTED TO DRYDEN DAM

FIGURE 11

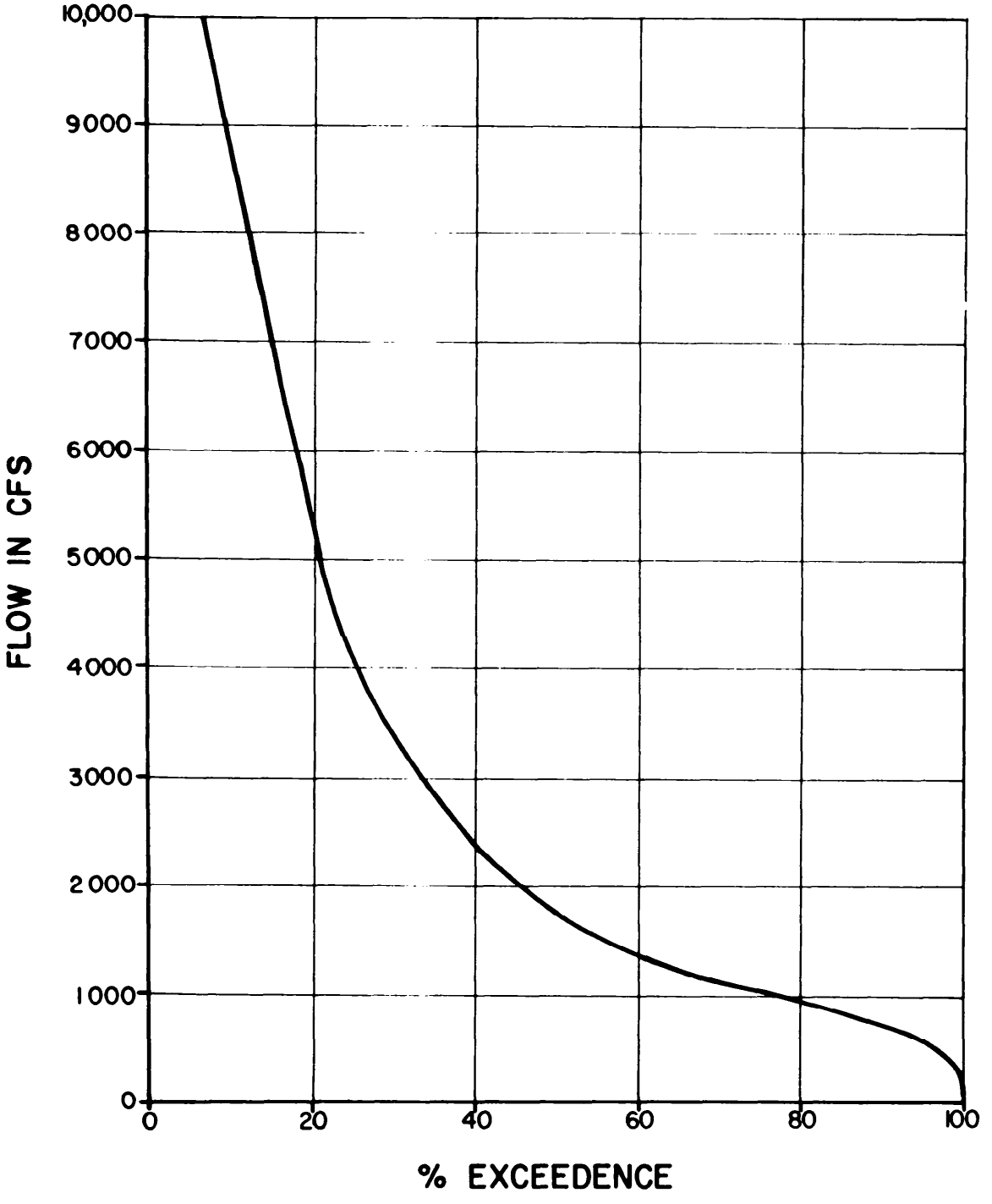
TUMWATER FALLS AND DRYDEN DAM
FISH PASSAGE PROJECT

DRYDEN DAM
MEAN MONTHLY HYDROGRAPH

DATE: MAY 1984

JOB NUMBER: S1019.01

OTT



NOTE: PESHASTIN GAGE DATA FROM 1930 TO 1981, ADJUSTED TO DRYDEN DAM

FIGURE 12

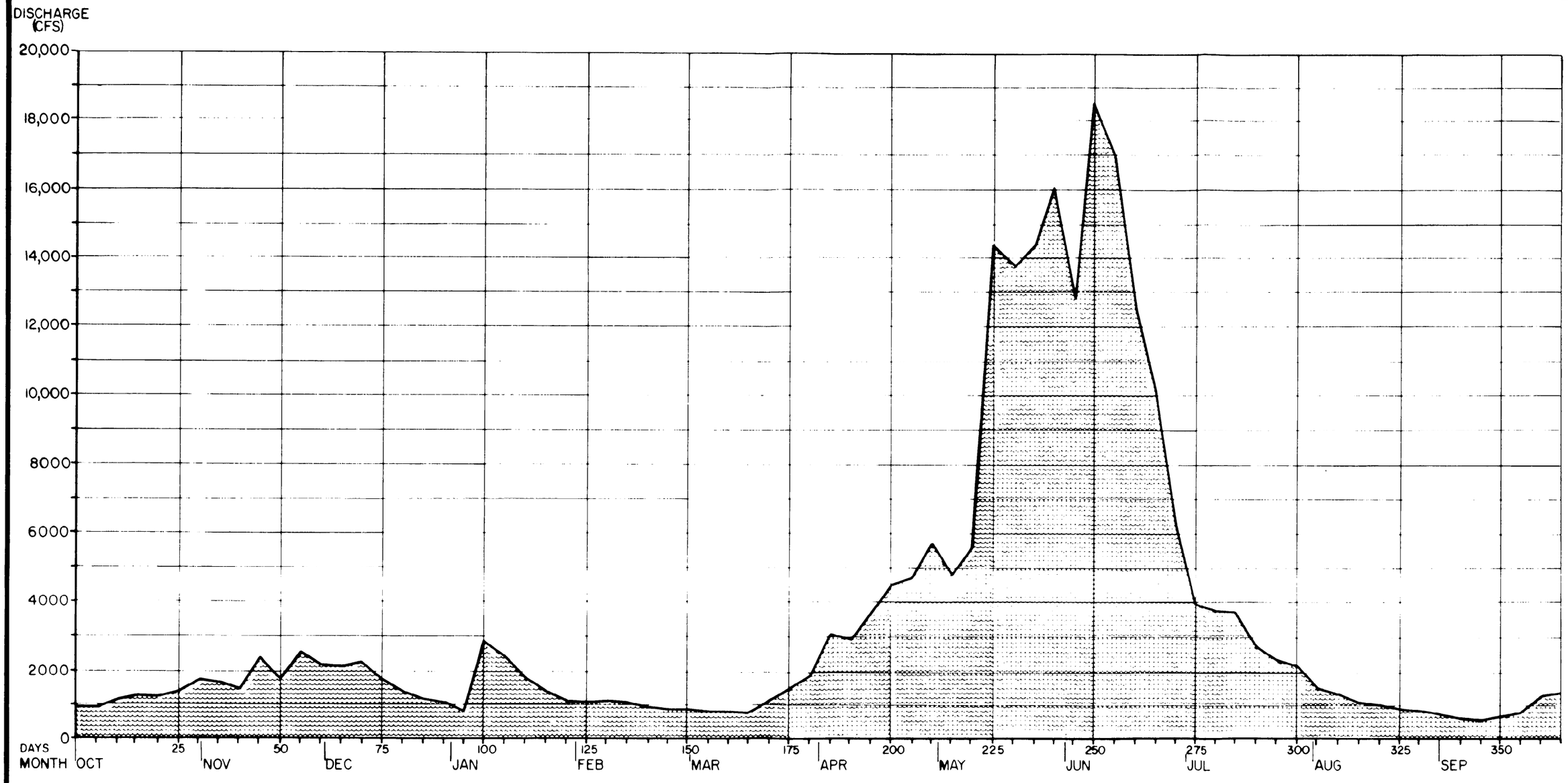
TUMWATER FALLS AND DRYDEN DAM FISH PASSAGE PROJECT

DRYDEN DAM
FLOW DURATION CURVE

DATE: MAY 1984

JOB NUMBER: S1019.01

OTT



NOTE: WATER YEAR 1969, PESHASTIN GAGE DATA ADJUSTED TO DRYDEN DAM

FIGURE 13

TUMWATER FALLS AND DRYDEN DAM
FISH PASSAGE PROJECT

TYPICAL WATER YEAR AT DRYDEN

DATE: MAY 1984

PROJECT NUMBER: S1019.01

OTT

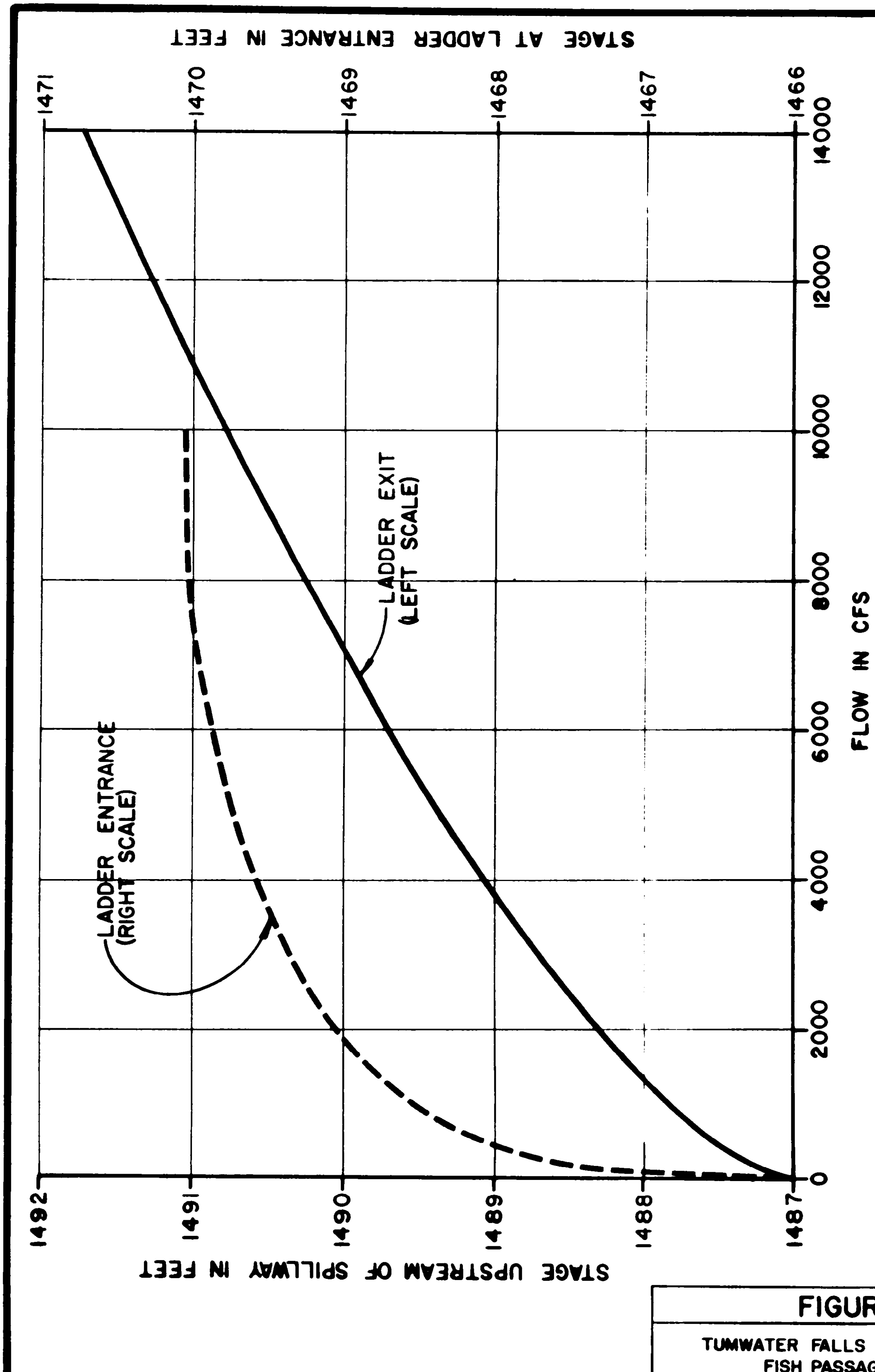


FIGURE 14

TUMWATER FALLS AND DRYDEN DAM
FISH PASSAGE PROJECT

TUMWATER FALLS STAGE-DISCHARGE RELATION

DATE: MAY 1984

JOB NUMBER: S1019.01

OTT

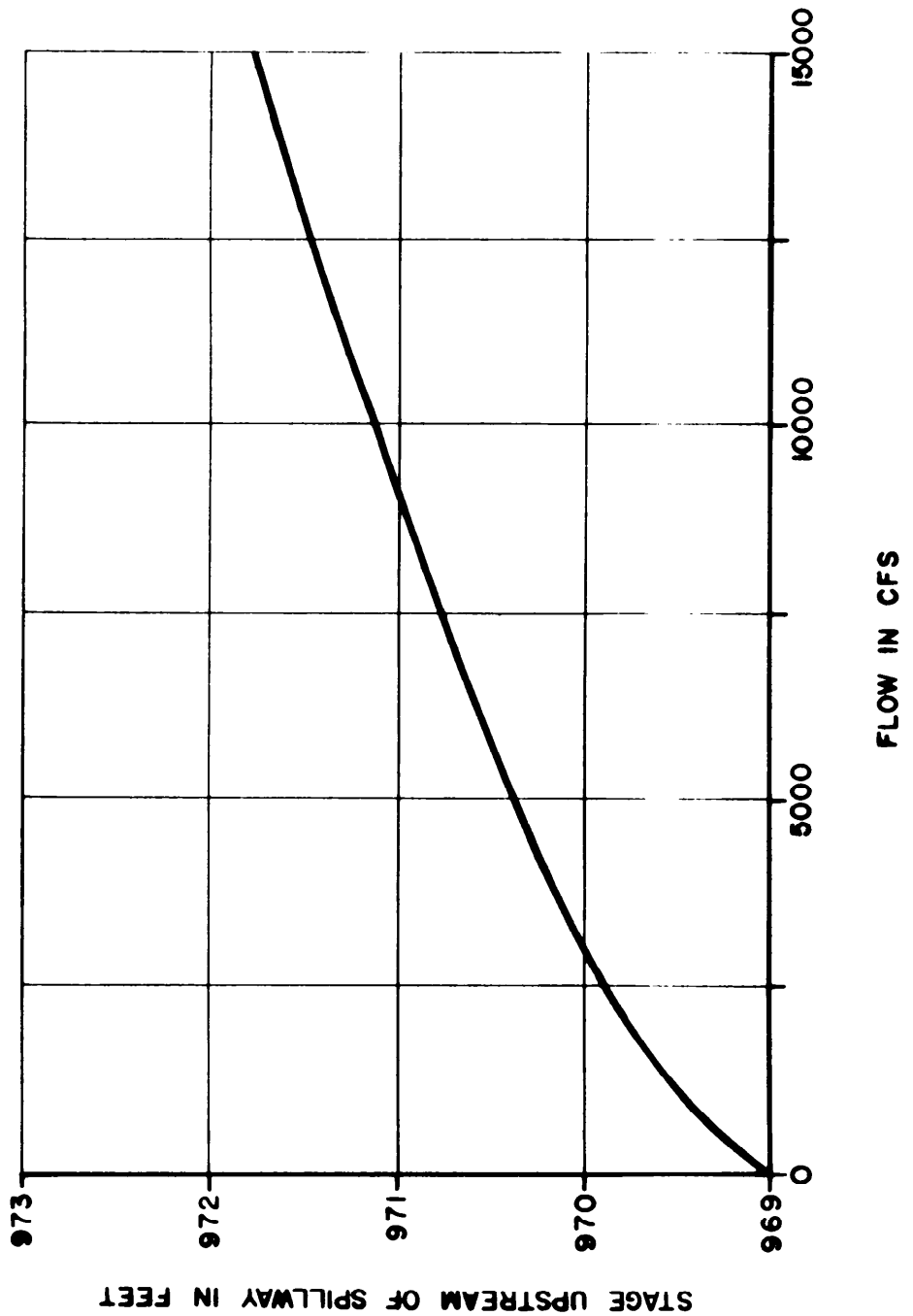


FIGURE 15

TUMWATER FALLS AND DRYDEN DAM
FISH PASSAGE PROJECT

DRYDEN DAM
STAGE-DISCHARGE RELATION

DATE: MAY 1984

JOB NUMBER: S1019.01

OTT

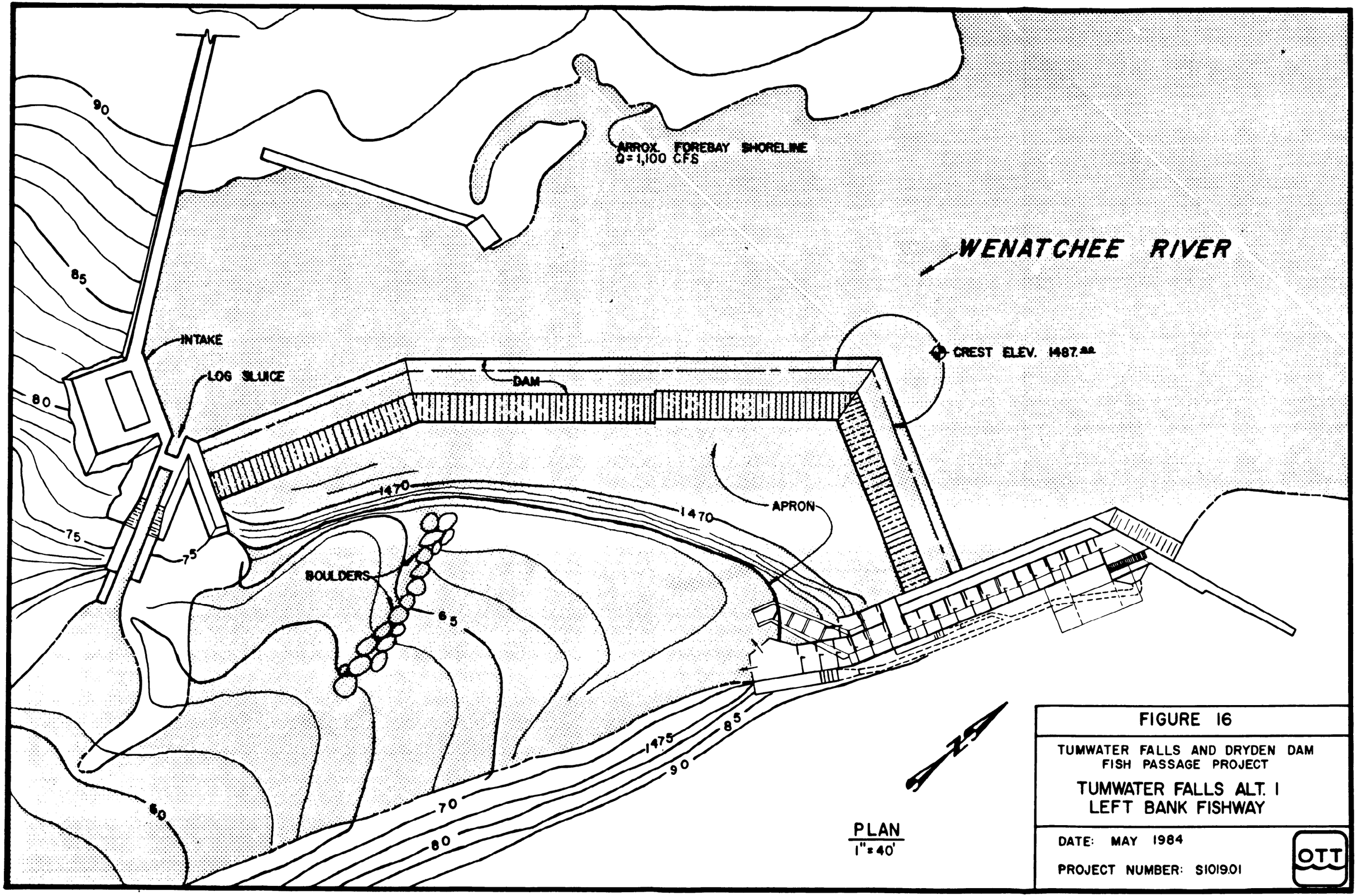


FIGURE 16

TUMWATER FALLS AND DRYDEN DAM
FISH PASSAGE PROJECT

TUMWATER FALLS ALT. I
LEFT BANK FISHWAY

DATE: MAY 1984

PROJECT NUMBER: S1019.01

OTT

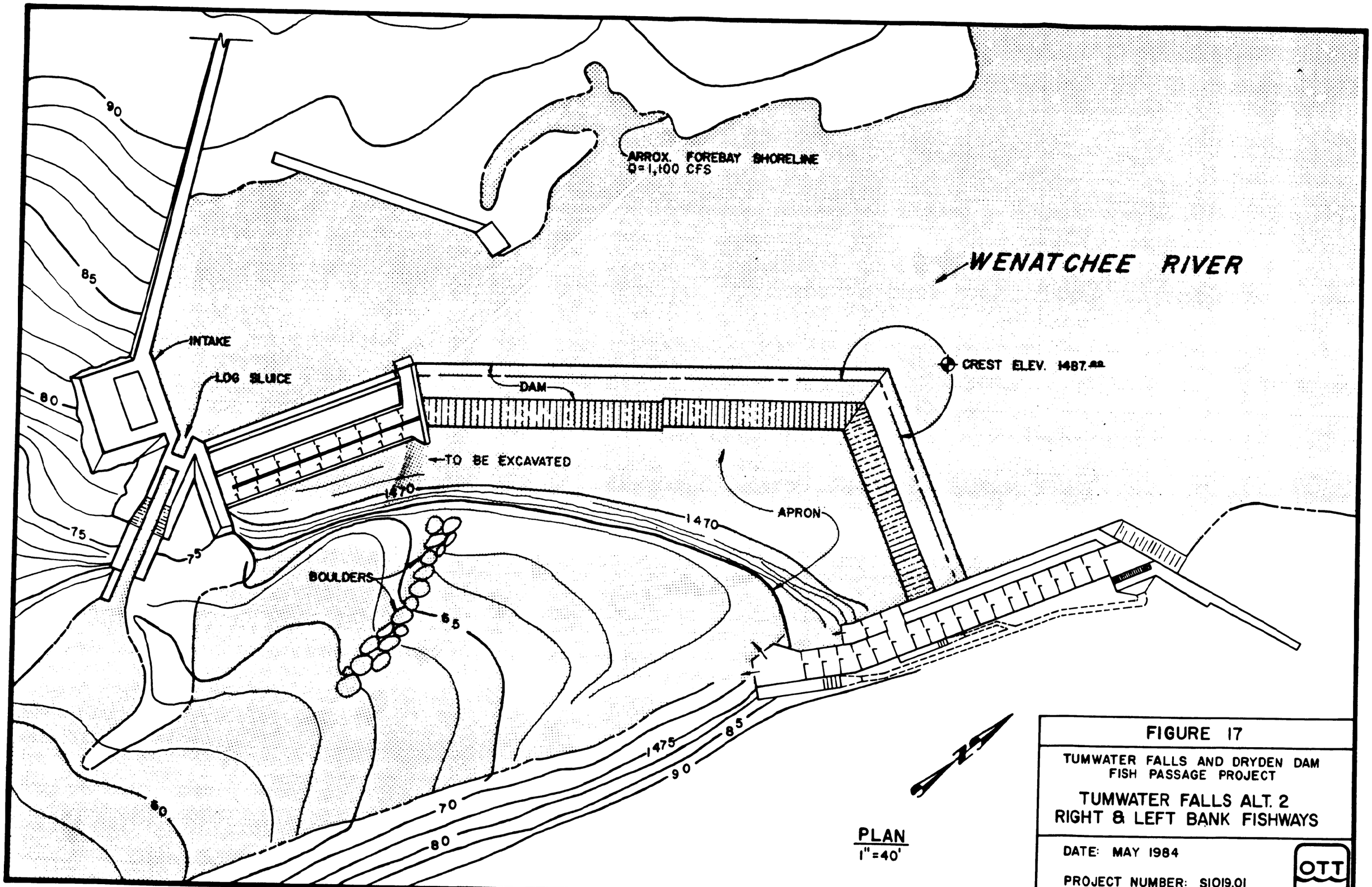


FIGURE 17

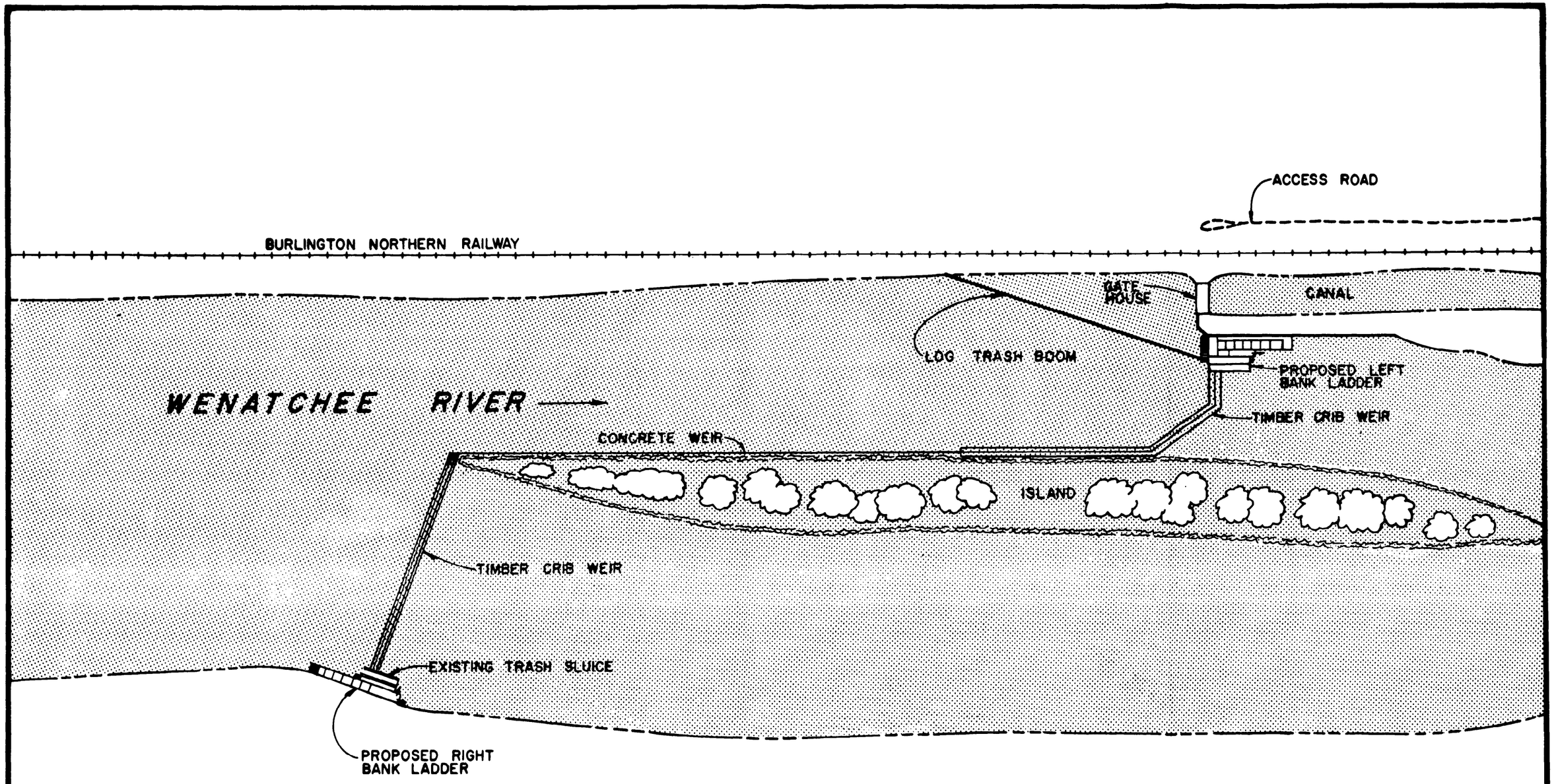
TUMWATER FALLS AND DRYDEN DAM
FISH PASSAGE PROJECT

TUMWATER FALLS ALT. 2
RIGHT & LEFT BANK FISHWAYS

DATE: MAY 1984

PROJECT NUMBER: S1019.01

OTT



PLAN
1"= 100'

FIGURE 18

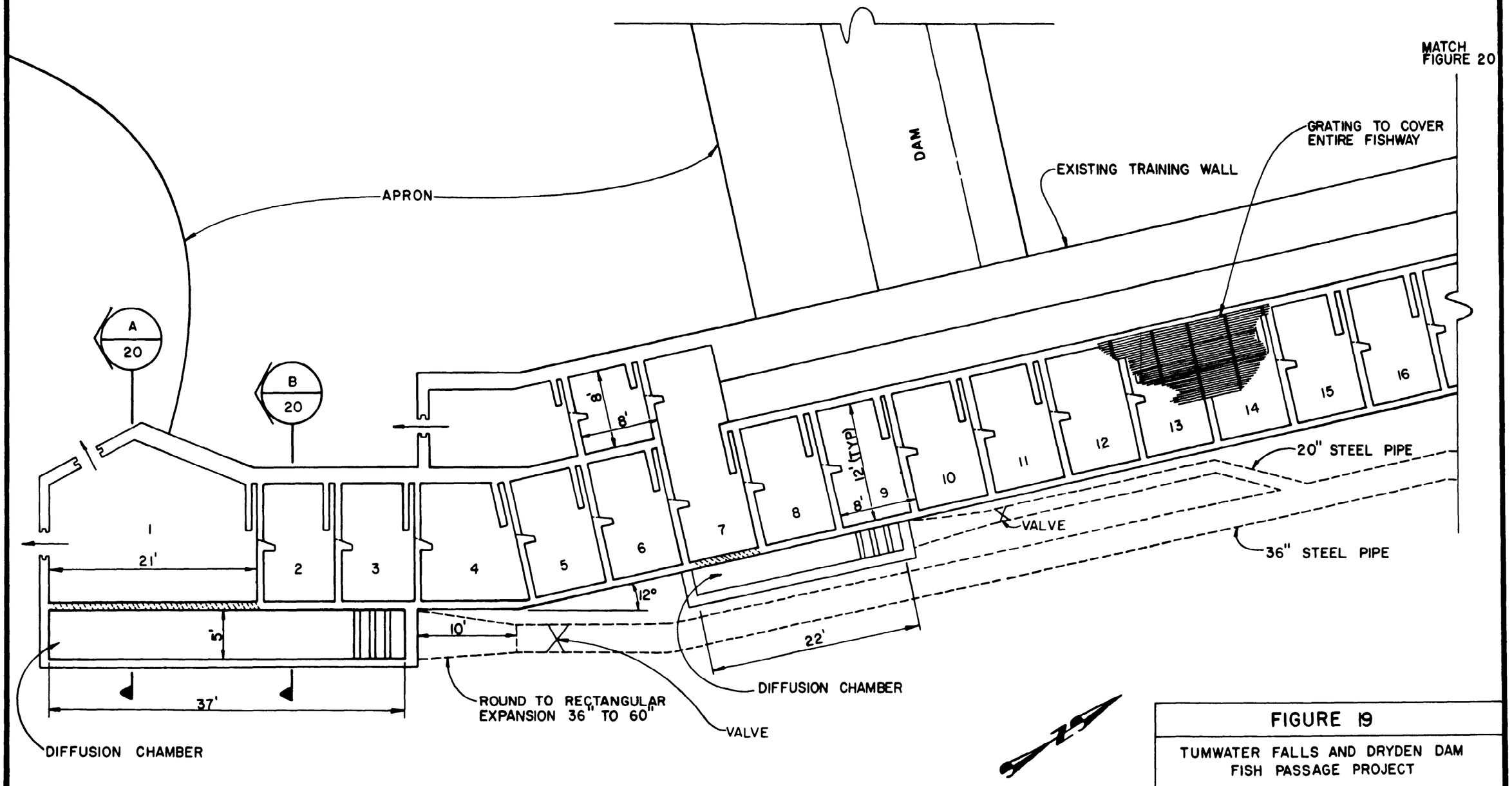
TUMWATER FALLS AND DRYDEN DAM
FISH PASSAGE PROJECT

DRYDEN DAM
PROPOSED FACILITIES

DATE: MAY 1984

PROJECT NUMBER: S1019.01

OTT



PLAN-DETAIL
1"=10'

FIGURE 19

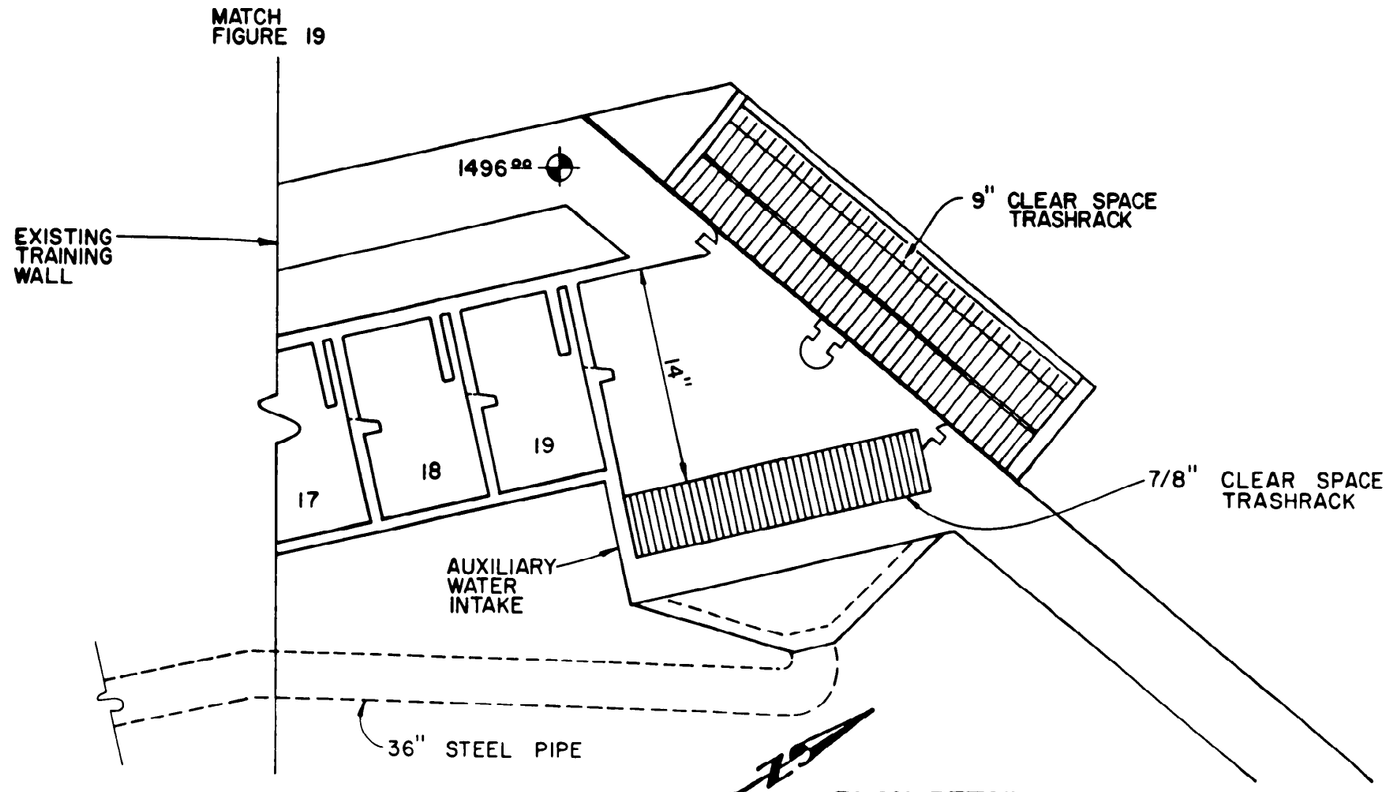
TUMWATER FALLS AND DRYDEN DAM FISH PASSAGE PROJECT

TUMWATER FALLS FISHWAY

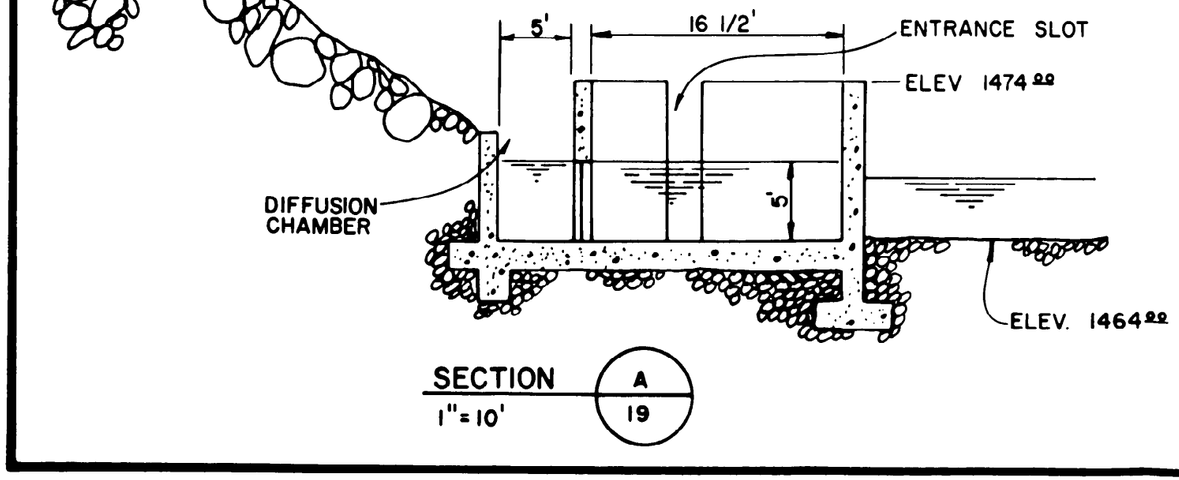
DATE: MAY 1984

PROJECT NUMBER: S1019.01

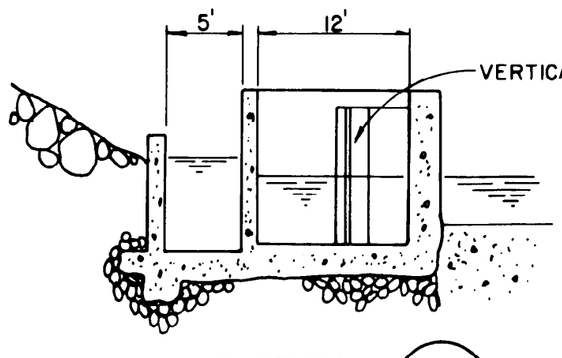
OTT



PLAN-DETAIL
1"=10'



SECTION A 19
1"=10'



SECTION B 19
1"=10'

FIGURE 20

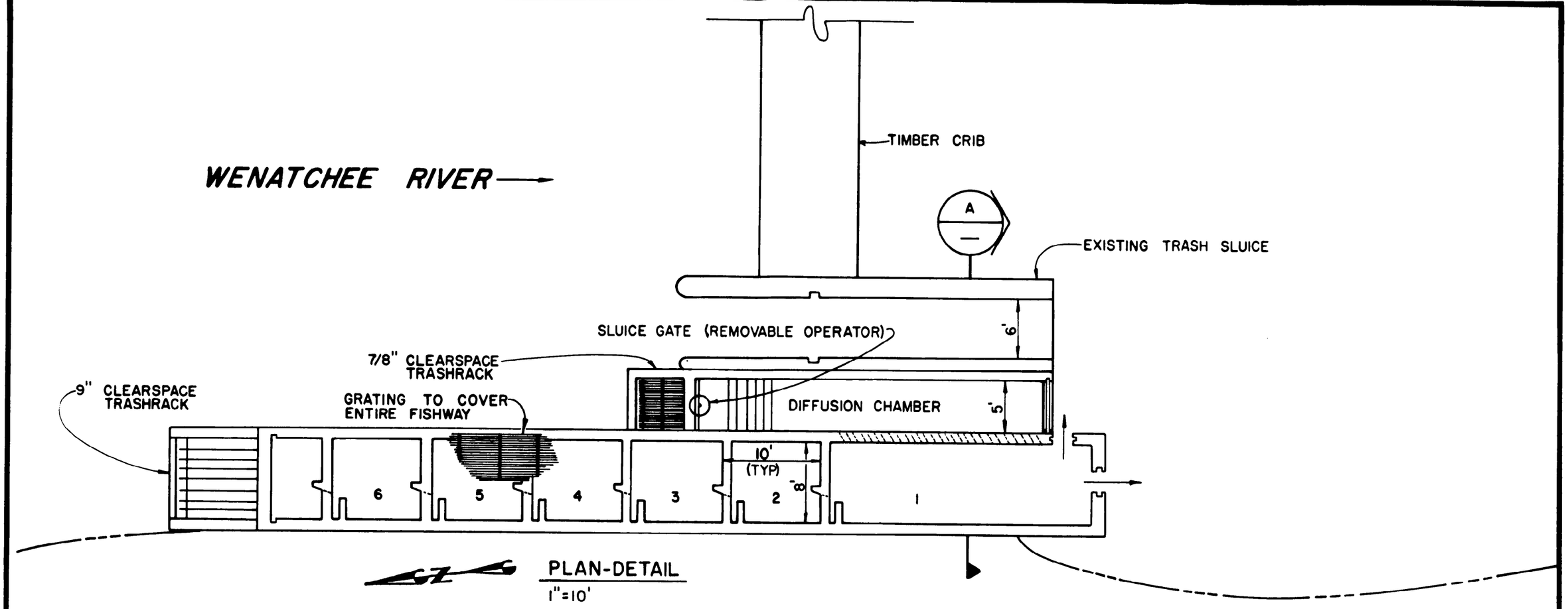
TUMWATER FALLS AND DRYDEN DAM
FISH PASSAGE PROJECT

TUMWATER FALLS
FISHWAY

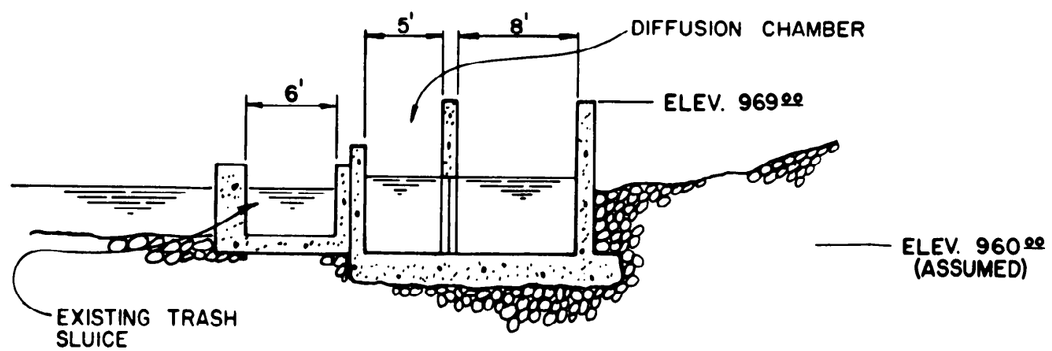
DATE: MAY 1984

PROJECT NUMBER: S1019.01

OTT



PLAN-DETAIL
1"=10'



SECTION A
1"=10'

FIGURE 21

TUMWATER FALLS AND DRYDEN DAM FISH PASSAGE PROJECT

DRYDEN DAM
RIGHT BANK FISHWAY

DATE: MAY 1984

PROJECT NUMBER: S1019.01

OTT

GATE HOUSE

CANAL

A
23

RETAINING WALL

B
23

EXISTING CONSTRUCTION

GRATING TO COVER ENTIRE FISHWAY

3'

9" CLEAR SPACE TRASHRACK

8'

10' (TYP)

4 5 6 7 8 9 10

3

26'

2 1

LOG TRASH BOOM

7/8" CLEAR SPACE TRASHRACK

DIFFUSION CHAMBER 5'

TRASH SLUICE 4'

SLUICE GATE

WENACHEE RIVER →

ELEV 969.00

TIMBER CRIB

PLAN-DETAIL
1" = 10'

FIGURE 22

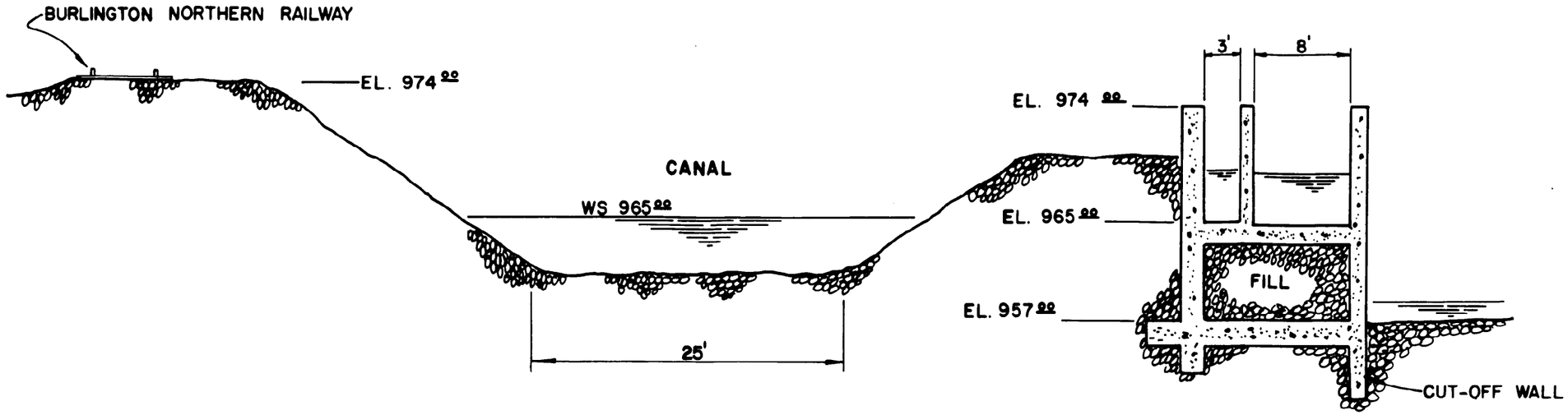
TUMWATER FALLS AND DRYDEN DAM
FISH PASSAGE PROJECT

DRYDEN DAM
LEFT BANK FISHWAY

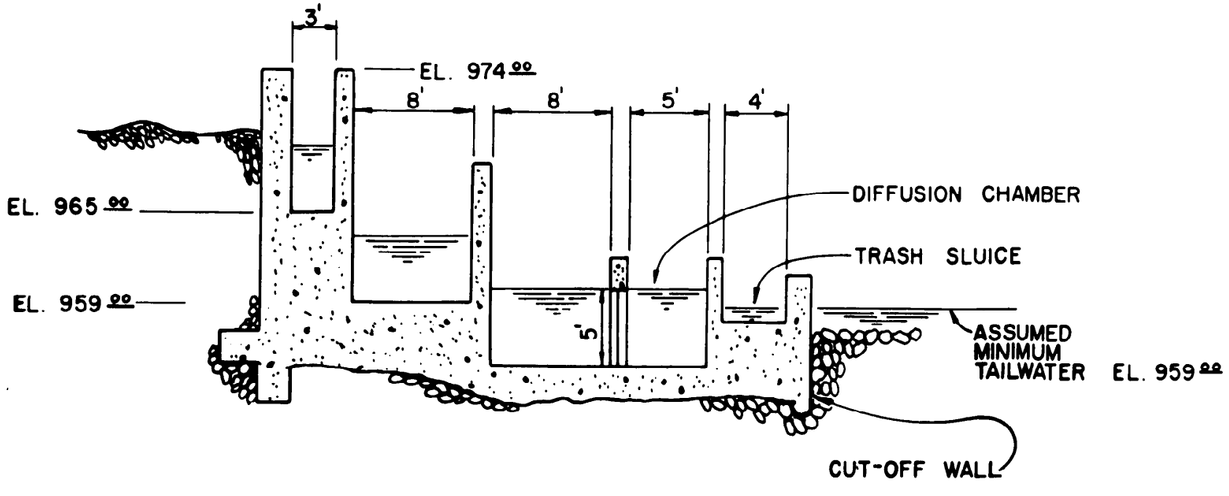
DATE: MAY 1984

PROJECT NUMBER: S1019.01

OTT



SECTION A
1" = 10'
22



SECTION B
1" = 10'
22

FIGURE 23

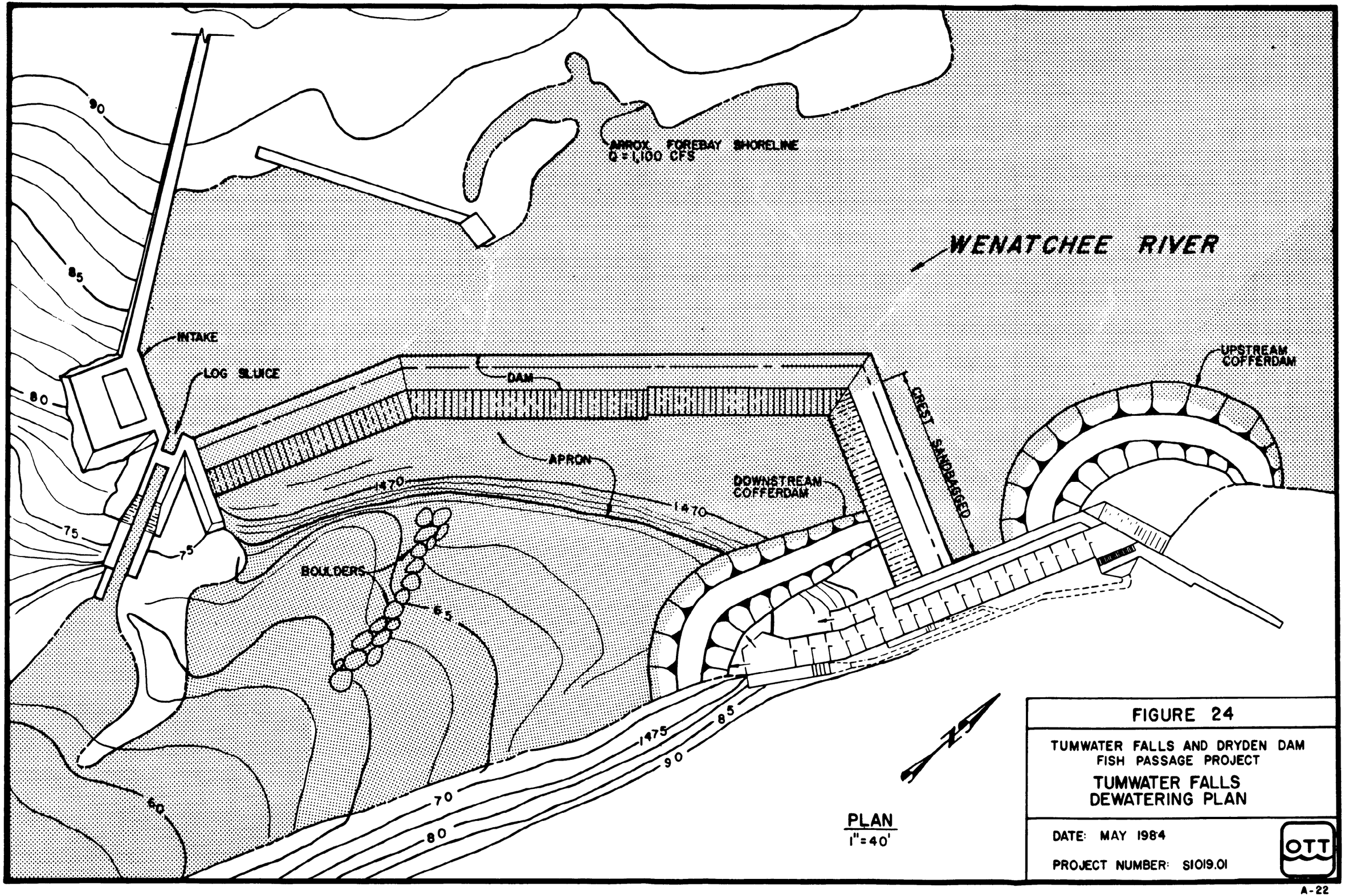
TUMWATER FALLS AND DRYDEN DAM
FISH PASSAGE PROJECT

DRYDEN DAM
LEFT BANK FISHWAY SECTIONS

DATE: MAY 1984

PROJECT NUMBER: SI019.01

OTT



PLAN
1"=40'

FIGURE 24

TUMWATER FALLS AND DRYDEN DAM
FISH PASSAGE PROJECT

TUMWATER FALLS
DEWATERING PLAN

DATE: MAY 1984

PROJECT NUMBER: S1019.01

OTT

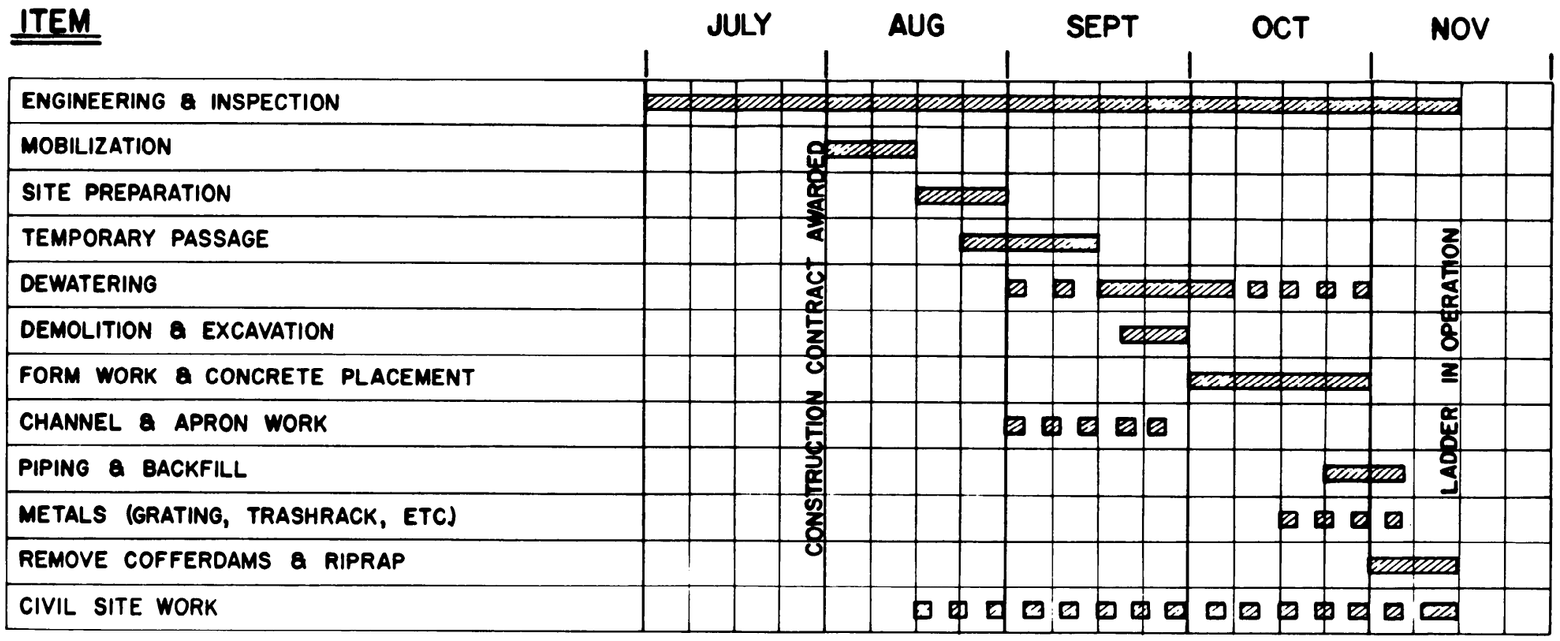


FIGURE 25

TUMWATER FALLS AND DRYDEN DAM
FISH PASSAGE PROJECT

TUMWATER FALLS
CONSTRUCTION SCHEDULE

DATE: MAY 1984

PROJECT NUMBER: 81019.01

OTT

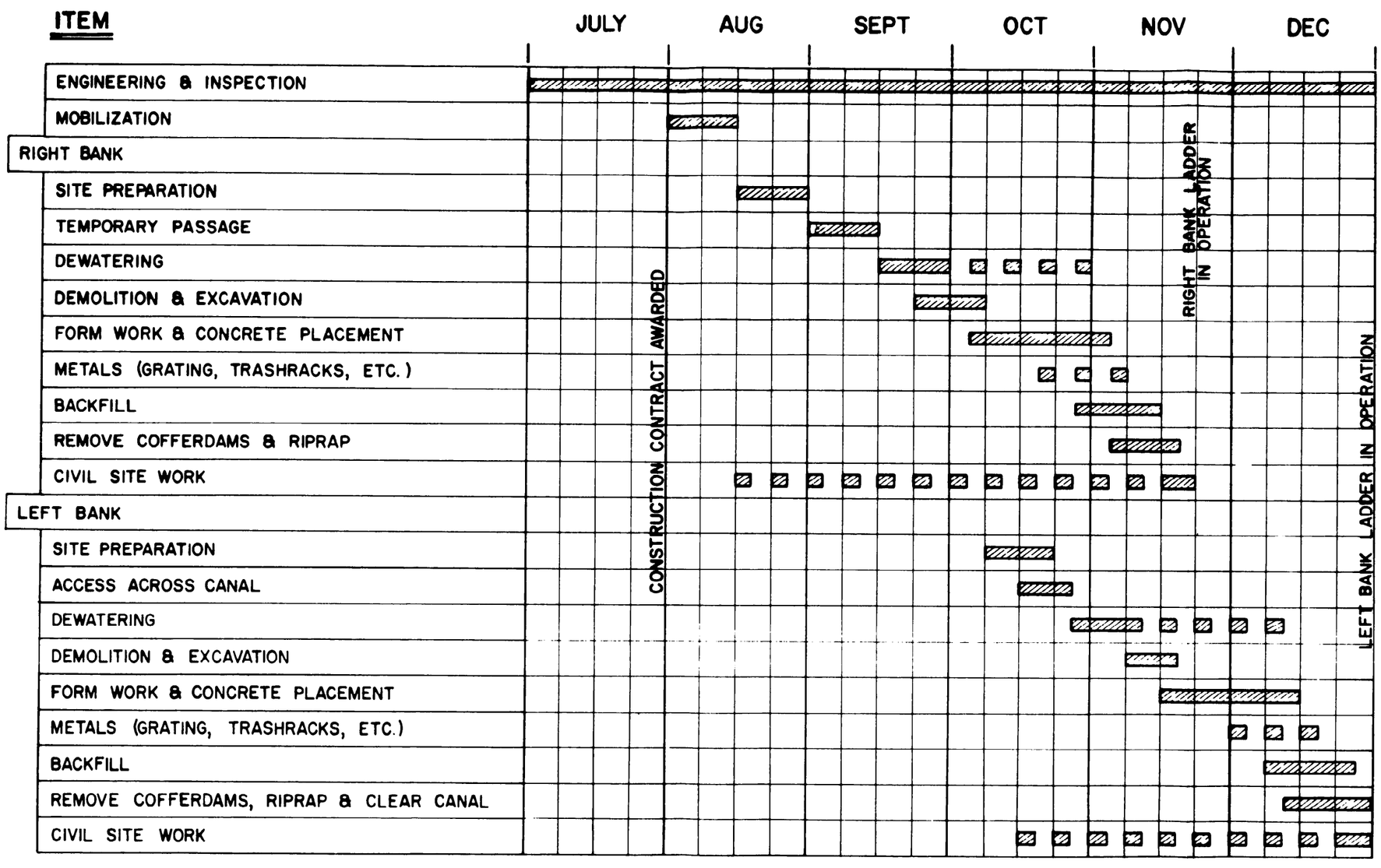


FIGURE 26

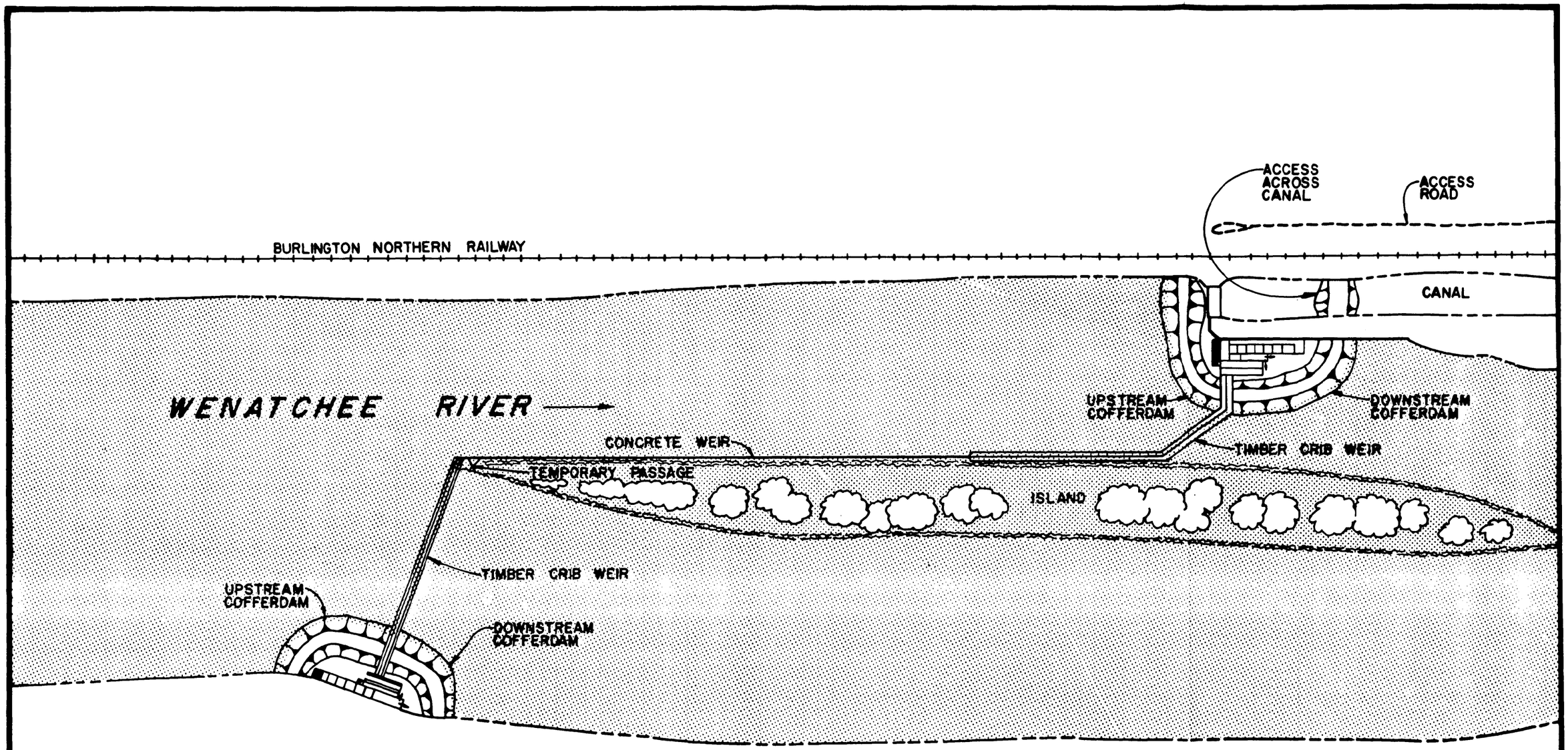
TUMWATER FALLS AND DRYDEN DAM
FISH PASSAGE PROJECT

DRYDEN DAM
CONSTRUCTION SCHEDULE

DATE: MAY 1984

PROJECT NUMBER: S1019.01

OTT



PLAN
1"=100'

FIGURE 27

TUMWATER FALLS AND DRYDEN DAM
FISH PASSAGE PROJECT

DRYDEN DAM
DEWATERING PLANS

DATE: MAY 1984

PROJECT NUMBER: 81019.01

OTT

FINAL REPORT

ENVIRONMENTAL REVIEW

TUMWATER FALLS AND DRYDEN DAM
FISH PASSAGE PROJECT

MAY 1984

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CHAPTER Page

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CHAPTER 1
INTRODUCTION

This report has been prepared for the Bonneville Power Administration (BPA) by Ott Water Engineers, Inc. (OTT) to provide a reference document for compliance with the National Environmental Policy Act in the development of two fish passage improvement projects on the Wenatchee River, Washington. Both the Tumwater Falls and Dryden Dam projects are discussed in this report. In general, the projects are discussed separately due to differences in individual features and environmental settings, but discussion is combined when possible. This report will provide the basis for BPA to conduct an Environmental Assessment on the projects and may be supplemented in the future by more detailed studies requested by other cooperating agencies or interest groups during the formal consultation period.

This document provides environmental information based on the preferred proposal presented in the accompanying Preliminary Engineering Design Report (hereafter Predesign Report). Alternatives are discussed in the last section of the Environmental Review. Information contained here also complements the Regulatory Permits Report for the two sites. Taken as a whole, the three reports provide complete preliminary information for the predesign and assessment of environmental effects and institutional arrangements necessary for construction.

SITE HISTORY AND SETTING

The proposed Tumwater Falls and Dryden Dam fish passage facility improvement projects are located respectively at the existing sites of Dryden and Tumwater Falls dams on the Wenatchee River near Leavenworth, Washington '(Figure 1). Both sites are owned by Chelan County PUD.

The sites currently have fish passage facilities; however, these facilities are in a state of decay and are less than adequate for fish passage. Anadromous fish migrating from the Pacific Ocean pass six major dams on the Columbia River to arrive at the Wenatchee River. The Columbia dams are Bonneville, The Dalles, John Day, McNary, Priest Rapids, and Rock Island. Having successfully passed these facilities, most of the Wenatchee fish runs then must pass Dryden Dam alone or Dryden Dam and Tumwater Falls to reach their ultimate spawning grounds.

TUMWATER FALLS

Tumwater Dam is located at river mile 30.9 at elevation 1487 ft. The dam is roughly 20 feet in height and was constructed in 1909 by the Great Northern Railroad as part of a hydroelectric project designed to power electric locomotives between Wenatchee and Skykomish. In the 1940's, the existing fish ladder was rebuilt by the Washington Department of Fisheries. Over time, the ladder has degraded and could be substantially improved.

DRYDEN DAM

Dryden Dam is located at river mile 17.6 at elevation 969. The dam is low, averaging 4-8 feet in height and was built in 1907 to provide water for irrigation and later hydroelectric power. The existing fish ladder is located on the right bank; however, to improve passage, two fish ladders are proposed, one on each bank.

SUMMARY OF PROPOSED ACTION AND ALTERNATIVES

At Tumwater Falls, the proposed action includes the construction of a new fish ladder with associated modifications which will improve water flow characteristics and, subsequently, fish

passage. The ladder will occupy the same location as the existing ladder, although its base area will be somewhat larger. Construction will occur through the use of cofferdams to provide a dewatered construction site. Temporary fish passage facilities will be installed to provide passage during construction. Public and highway access will be maintained adjacent to the site although direct public access on the site will be curtailed during the actual construction period. Highway access will be subject to only minor interruptions due to movement of equipment. All equipment will be based from the left bank.

At the Dryden Dam site, one fish ladder will be constructed on the right bank to replace the existing ladder. A new ladder will be constructed on the left bank at the site of an existing trash sluice. Equipment will be based on both sides during construction. Limited equipment crossing of the river bed will occur only during the low flow period for the construction of the temporary fishway. Dewatering will be provided by means of earth and rock cofferdams.

Alternatives to the proposed action include:

1) No action
2) Proposed action of improving Tumwater Falls fish ladder and improving the right bank ladder and adding a left bank ladder at Dryden Dam
3) Construction of Tumwater ladders on both banks and Dryden ladders on both banks
4) Minor modification of existing ladders (including improved on-site maintenance) and adding a left bank ladder at Dryden

Each of these alternatives will be discussed following the presentation of existing conditions, potential impacts and mitigation outlined in the following sections for each environmental

category. Impacts and mitigation are for the proposed action and represent results for the project as proposed in the Predesign Report.

Environmental analysis is provided for the following areas:

- Land Use
- Vegetation
- Wildlife
- Fisheries
- Hydrology
- Water
- Air Quality
- Solid and Hazardous Waste and Toxic Materials
- Topography, Geology and Soils
- Cultural and Historic Resources
- Recreation
- Noise
- Aesthetics
- Economics
- Alternatives

CHAPTER 2
LAND USE

EXISTING CONDITIONS

Introduction

This section describes the geographic orientation of the sites, the regional land uses and the surrounding land ownership. Transportation and population are not treated separately; however, a brief description of area transportation and population is included. The Wild and Scenic Rivers Act and the goals and policies of the Shoreline Master Program are explained as they relate to the proposed project sites. General land uses in the immediate vicinity of each site are also discussed.

Geography

The sites are located in two distinct geographic areas, though they are only 13.3 miles apart (Figure 2). Tumwater Falls is located along the mid-section of Tumwater Canyon; approximately 3.5 miles upstream of the Wenatchee Valley and 4 miles northwest of Leavenworth. The Wenatchee River at Tumwater Falls has a steep gradient and is surrounded by steep forested canyon walls.

Dryden Dam is located in the Wenatchee Valley. The valley extends approximately 20 miles southeast, originating at Leavenworth and ending at the Columbia River. In this reach, the Wenatchee River is a moderately braided, low gradient stream. The lands surrounding Dryden Dam are open high desert-type valley lands. The geographical differences in the sites inherently affects the types of existing and current trends toward land uses.

Land Uses and Ownership

The majority of the land surrounding both sites is undeveloped open space or is used for agricultural purposes. The land surrounding the Tumwater Canyon is largely undeveloped. Some grazing and hay crops are found north of the canyon. The Wenatchee Valley lands near Dryden are predominantly fruit orchards, a major product for Washington State.

The undeveloped lands are also used for recreation, especially along the Wenatchee River. The Wenatchee River is very popular for white water boating, fishing and swimming. Few developed recreational use areas surround Tumwater Falls and Dryden Dam, however, campgrounds and picnic areas are located nearby. A separate discussion of recreational resources is provided in the Recreation Chapter of this report.

Very little development occurs in the region. Development is concentrated in the communities of Dryden, Peshastin and Leavenworth. Residential development occurs predominantly in these communities, although scattered dwellings are located along the Wenatchee River. Recreational homes exist in private subdivisions and on forest lands under special use permits. The U.S. Forest Service does not plan to issue any more special use permits for recreational homes and plans to consolidate land ownership within the National Forest boundaries (Chelan County Regional Planning Council 1973).

Commercial areas are predominantly tourist oriented. They are located along the main transportation routes, Highway 2 and 97, with most of the concentration in the communities. The largest commercial concentration is in the community of Leavenworth.

Industrial land use is oriented towards fruit distribution and processing. Most of the industrial land use in the region is

located in Peshastin along the left bank of the Wenatchee River. Other industrial land uses are located in small areas in Dryden and Leavenworth.

General land ownership in the area consists of the Wenatchee National Forest which covers the majority of Chelan County. Most of the privately-owned lands are within the Wenatchee Valley. Both Tumwater Falls and Dryden Dam are located on Chelan County PUD lands.

Tumwater Falls

The Tumwater Canyon is nine miles long and is a high public recreational use area. The majority of the land around the Tumwater site is owned by the Wenatchee National Forest (Figure 3). Some of the surrounding forest slopes have been logged in the past although there is no evidence of current harvest activities. Chelan County PUD owns the dam, the old caretaker house and some land at the site. Some development occurs several miles to the southeast near the community of Leavenworth. The dam creates Lake Jolanda upstream of the site. The Alps Gift Shop and owner's residence are located on the lake. North of Lake Jolanda is an area designated as the Tumwater Botanical Area. This area was set aside to protect the rock rose (Lewisia tweedyi) which is listed as a candidate endangered species on the Federal Register.

Highway 2 follows the east side of the canyon directly above Tumwater Falls. Roadside parking is currently available and consists of a broad shoulder adjacent to the highway. There are no formal walkways and pedestrian access to the site is limited by fencing.

The West Central Chelan County Comprehensive Plan for Tumwater Canyon specifically proposes to develop it as scenic recreational

corridor. This would direct development toward recreational activities. Permitted development includes overnight camping facilities, tourist services, and recreational condominium development, provided activities comply with local environmental policies (Chelan Co. Regional Planning Council 1973). Residential development and recreational subdivision are discouraged in the area.

The long-term plans of the Forest Service include the establishment of additional campgrounds in the area which would attract tourism to Tumwater Falls. The Chelan County Comprehensive Plan does not specifically state objectives that relate to conservancy projects such as fish ladders.

Dryden Dam

The majority of land around the Dryden Dam site is privately owned and used for irrigated orchard agriculture (Figure 4). Lands surrounding the orchards are undeveloped. Chelan County PUD owns the diversion weir, headworks and canal (now used for irrigation). Chelan County PUD also owns approximately 11.4 acres of land downstream of the site surrounding the old powerhouse. Land held by the U.S. Bureau of Land Management (BLM) is located on the left side of the upstream portion of Dryden Dam. A Washington Department of Transportation (DOT) gravel stockpile is located on the right side of the stream, upstream of the site. Private lands occur along both sides of the Wenatchee River downstream from the site. Orchard production, fruit processing and distributing, and grazing comprise the major land uses in the area.

The community of Dryden is located downstream of the Dryden Dam site. The community consists of single-family dwellings, a post office, school, fruit processing and distributing plant and a small commercial area (Chelan County PUD 1980).

The Burlington Northern Railroad skirts the left bank of the site. Unimproved roads provide access to the site from the main highway (Highways 2 and 97). Storage and parking is already available at the site, although along the left bank a temporary access road will be required to cross the canal.

The Comprehensive Plan of the Wenatchee Valley includes the maintenance of a rural environment, the preservation of agricultural lands, and the preservation and enhancement of the scenic resources and recreation (Chelan County Planning Commission 1972). The Plan does not have any goals and policies related directly to fish and wildlife enhancement measures such as fish ladders.

Transportation

Transportation routes in the area have considerable influence over types and distribution of land uses. Highways 2 and 97, designated as primary state highways, are the main transportation routes in the area. Highway 2 is a main link from western to eastern Washington. Highway 97 links southern Washington to northern Washington. Highways 2 and 97 converge south of Peshastin and diverge at Wenatchee along the Columbia River. The highways bring many tourists into the area thereby creating recreational land use needs, and sustaining many commercial land uses. The highways facilitate the distribution of agricultural products, important links in development of agricultural and industrial land uses. The heaviest traffic occurs over the weekends and during summer months.

Burlington Northern Railway is also an important link between eastern and western Washington.

Population

Trends in the population have a significant impact on types of land uses in an area. Changes in land use will be dependent on the future population changes. Chelan County has a significant number of seasonal visitors; the population increases three or more times in the summer months (Chelan County Regional Planning Council 1973).

According to the U.S. Census of 1980, the Census Enumeration District #66 (which includes Leavenworth, Tumwater Canyon, Chumstick and Plain Valleys and the Lake Wenatchee area) gives a total population of 2,034. The total number of dwelling units is 1,929 and the total number of year-round dwelling units is 1,295. Most of the population is located in Leavenworth. Tumwater Canyon has no measurable population. Chumstick and Plain Valleys and the Lake Wenatchee area have undergone substantial development, especially along Lake Wenatchee.

Census Enumeration Districts #70 and #71 cover the Peshastin and Dryden areas. In 1980, the total population was 2,910; the total number of dwelling units was 1,260; and the total year-round number of dwelling units was 1,116. The concentration of dwellings is mostly in the communities of Peshastin and Dryden with some scattered along the Wenatchee River.

The population in the region has remained fairly constant over the last several years. A slight increase has taken place since 1960 which is due mainly to the demand for recreation and retirement living (Chelan County Regional Planning Council 1973). An increase in population is expected but only from recreational users.

Wild and Scenic Rivers Act

In 1977, the Wenatchee River was selected by the National Heritage and Recreation Service for consideration for wild and scenic river status. The Wenatchee River in its entirety was included under Section 5(d) of the National Wild and Scenic Rivers System which states: "Specific evaluations are required on Federally authorized or licensed projects bearing this 5(d) status". Section 5(d) does not prohibit development but requires agencies to consider the wild, scenic or recreational values for which the river was selected (Chelan County PUD 1980).

According to the National River Inventory, the Wenatchee River in the area of Tumwater Falls and Dryden Dam has "outstandingly remarkable" values especially for recreation. The lower Wenatchee is one of the most important white water rivers in the state, if not the most important. Its high level of use and white water value justify the value rating (Chelan County PUD 1980).

Shoreline Master Program

The purpose of the Shoreline Master Program is essentially to protect the shoreline environment. The following discusses goals and policies that are related to the proposed Tumwater Falls and Dryden Dam projects.

> "Goal for Conservation Element. Assure preservation of unique, fragile and scenic element; assure conservation of non-renewable resources; assure continued utilization of the renewable resources such as timber, water and wildlife." (Chelan County Planning Dept. 1979)

Since the proposed project involves the improved passage of fish, it falls into this goal to conserve wildlife.

Policies are related to different types of activities on shorelines. The policy that relates to the proposed Tumwater Falls and Dryden Dam projects is the Shoreline Works and Structures, which includes the following:

> "Construction in a manner...to cause no significant adverse effects on adjacent shorelines ...minimize alterations of natural shoreline...have no long-term adverse effects on fish habitat." (Chelan County Planning Dept. 1979)

The Shoreline Master Program designates shorelines as "urban", "rural", "conservancy" and "natural"; proceeding respectively, from the most developed to the most protected categories.

Environmental designations for Tumwater Falls are conservancy on the left shoreline and natural on the right shoreline. Environmental designations for Dryden Dam are conservancy on the left shoreline and rural on the right shoreline The projects will affect only conservancy and rural designations.

Regulations for activities on shorelines are given for each environmental designation. The three environmental designations of the proposed projects include regulations that prohibit shoreline works and structures that "substantially change the character of the environment" and that are not "defined as water dependent or water related." Areas designated as "rural" must comply with these regulations while the "conservancy" designation also includes regulations that prohibit shoreline works and structures unless "the project would be rendered impossible or completely infeasible without it." The "natural" designation includes regulations that prohibit shoreline works and structures "except where necessary to protect or preserve the character of this environment" (Chelan County Planning Dept. 1979).

POTENTIAL IMPACTS

Land Uses

The impacts on land use of the proposed projects will be short term and will occur during construction when recreational uses such as river rafting, fishing and swimming will be affected. River rafting is very popular between Leavenworth and the Wenatchee River County Park near Monitor. (For further details, refer to Recreation.) At Dryden Dam, rafters will usually take out their rafts before the diversion weir and return them down-stream. During higher flows, some rafters will float over the weir. During construction, rafters will not be permitted to float over the weir. Fishing and swimming at both the Tumwater Falls and Dryden Dam sites will be impossible during construction.

Transportation

Access will be affected during construction at both sites. State Highway 2 at Tumwater Falls is directly above the site and general traffic will be periodically slowed to provide passage and operation of construction related vehicles. Normal Highway 2 traffic flow will be reduced for 3 to 4 months between August and November. Trucks will have to exercise caution when entering the parking lot and leaving the site.

The Dryden Dam site is accessible through dirt access roads coming from Highway 2/97. These roads support a low density of local traffic. Trucks used during construction will create additional traffic on those access roads. During construction on the left bank fishway, trucks will need to cross Burlington Northern Railway. Coordination with the railroad will be necessary to prevent the possibility of collisions.

Construction-related vehicles will result in a slight increase in traffic on Highway 2 by Tumwater Falls and Highway 2/97 by Dryden Dam. Delays along Highway 2 are expected to be short-term and minor. NO long-term impacts are anticipated. There may be an increase in traffic and recreational uses in the area due to tourists who come to view the fish in the new fishways. However, the effects will be negligible since the long-term goals in the comprehensive plans in the area encourage recreational use and tourism.

Wild and Scenic Rivers Act

Although both portions of the project occur on a river which is identified as an "outstandingly remarkable" value, no long-term alterations to those values will result from project development. This is due to the fact that the proposed improvements will occur at existing facilities with little or no changes to the surrounding scenic or recreational values.

No significant adverse impacts are anticipated.

Shoreline Master Plan

The proposed projects comply with the regulations of the Shoreline Master Plan regarding shoreline works and structures in the "conservancy" and "rural" shoreline designations. No shorelines designated as "natural" will be affected.

No significant adverse effects to the Shoreline Master Plan will occur.

MITIGATION

The fishways will not change the dams at the sites; therefore, the character and land use at the sites will not differ.

Construction will be temporary: therefore, recreational uses at the site will be affected for only a short time. Access will be given to river rafters and floaters around the construction site at Dryden Dam.

On-site, off-road storage of material and equipment will be provided at the Tumwater Falls site to avoid congestion on Highway 2. Flagmen will be used when necessary to ensure safety of workers and travelers using Highway 2. Closure of the highway is not anticipated.

In order to decrease the potential for collision with construction vehicles and Burlington Northern trains, railroad crossings and train schedules will be coordinated.

CHAPTER 3
VEGETATION

Tumwater Falls and Dryden Dam lie within the eastern boundary of the Northern Cascade physiographic province. The slopes surrounding Tumwater Falls support a ponderosa pine-mixed conifer forest while at Dryden Dam surrounding terraces support productive fruit orchards. At both sites, riparian vegetation directly surrounds the project facilities. Primary components of the vegetation at Tumwater Falls and Dryden Dam vary considerably and are discussed separately in the following sections.

EXISTING CONDITIONS

Site Vegetation

Tumwater Falls

Tumwater Falls lies within Tumwater Canyon. Slopes surrounding the site are dominated by mixed conifer forest. The primary species are ponderosa pine (Pinus ponderosa) with Douglas fir (Pseudotsuga menziesii), western red cedar (Thuja plicata), incense-cedar (Libocedrus decurrens), white fir (Abies concolor) and lodgepole pine (P. contorta) as secondary species. Scattered shrubs include bearberry (Arctostaphylos spp.), gooseberry (Ribes spp.) and buckbrush (Ceanothus spp.).

The deciduous riparian shrub community currently surrounds the existing facility. Red alder (Alnus rubra), willows (Salix Spp.) and vine maple (Acer circinatum) are sparsely scattered along the river banks and gravel bars. Occasional dogwood and pine saplings have also become established.

Dryden Dam

The Wenatchee River at Dryden Dam is surrounded by alluvial terraces. The natural vegetation is the sagebrush-wheatgrass association. Dominants include shrubs such as: big sagebrush (Artemisia tridentata); bitterbrush (Purshia tridentata); stiff sagebrush (A. rigida); scattered ponderosa pine: and perennial grasses such as bluebunch wheatgrass (Agropyron spicatum); and Idaho fescue (Festuca idahoensis).

The sagebrush-wheatgrass association is extensive throughout eastern Washington. Locally, much of the natural vegetation of the terraces has been removed and is currently managed for pear and other fruit production.

Along the right bank at Dryden, a gravel stockpile and an unimproved parking area provide access to the dam structure. Most of the natural vegetation has been removed but the remaining riparian shrub community includes white alder (Alnus rhombifolia), willows, vine maples, black cottonwood (Populus spp.), and ponderosa pine. The vegetation is sparse in this vicinity; however, denser stands of deciduous riparian species occupy surrounding streambanks and gravel bars.

The composition of the vegetation along the left embankment of the facility also displays the effects of the surrounding land use activities. Both Burlington Northern Railway and the Wenatchee Reclamation District control the growth and density of existing vegetation to maintain the use and access of their right-of-ways. The railway lies within 50 feet of the gatehouse and the irrigation canal abuts the left wall of the existing trash sluice.

Common plant species in the riparian zone of the left bank include: willow, cascara (Rhamnus purshiana), red. alder and a variety of common grasses and forbs.

Protected Plant Species

No sensitive, threatened, or endangered plant species protected by the Federal Endangered Species Act of 1973 (as amended 1978) have been observed at or are known to occur within either of the project sites. Three sensitive State plant species may occur in the project vicinity as indicated below for each site.

Tumwater Falls - The snowy stickseed (Hackelia venusta) is a Washington State endangered species and has been nominated as a candidate species to the Federal Register List (1980) of Threatened or Endangered Plants. Its habitat is rocky slopes under ponderosa pine vegetation.

The Tumwater Botanical Area located upstream of Tumwater Falls was designate? to protect limited populations of the endemic Lewisia tweedyi. The species has been recommended for Federal protection (1980) and is designated as a sensitive species by the State.

Dryden Dam - The yellow-white larkspur (Delphinium xantholeucum) has been observed in the surrounding area. The species has also been nominated for Federal protection (Washington Natural Heritage 1981) and has been identified by Washington State as a threatened species.

The Natural Heritage Program has conducted a computer search to identify the locations and species of protected plant communities in the project areas. The snowy stickseed has been reported on steep slopes above Highway 2 above Tumwater Falls. The closest known locations of special plants near Dryden Dam occur at Peshastin in meadow areas (Sprague 1984).

POTENTIAL IMPACTS

Improvement of the fishways at the Tumwater and Dryden sites will create very minor effects on the existing vegetation. A minimum of vegetation will be removed from the riparian zones; no upslope vegetation will be removed.

At Tumwater Falls, site preparation and construction of the east bank would remove less than 400 square feet of vegetation. No unique habitats or protected plant species will be affected by the proposed project development.

At Dryden Dam, the fishway construction will remove less than 500 square feet of vegetation along the west embankment. The fishway proposed along the east embankment will upgrade the existing retaining wall along 150 feet of its upstream length.

No critical habitats or protected plant species will be affected by project construction or fishway operation.

MITIGATION

NO mitigation measures for vegetation are necessary or appropriate.

An on-site sensitive plant survey is not recommended at this time because no unique or critical habitats are known to occur at either of the areas of project impact.

CHAPTER 4
WILDLIFE

EXISTING CONDITIONS

Habitat and Species

Tumwater Falls

The ponderosa pine-mixed conifer habitat and the adjacent riparian habitat provide nesting, rearing and feeding habitats for several wildlife species.

Ponderosa Pine-Mixed Conifer Forest Habitat - The forest habitat is multi-layered and provides cover for numerous resident species. Typical mammal species which reproduce and/or feed in the rocky canyon slopes are the bobcat (Lynx rufus) the mountain lion (Felis concolor), the bushy tail woodrat -(Neotoma cinerea), and the western. grey squirrel (Sciurus griseus). Game mammals include elk (Cervus canadensis) and deer (Odocoileus spp.).

Avian species such as Clark's nutcracker (Nucifraga columbiana) feeds on pine seeds. The black-capped chickadee (Parus atricapillus) also occurs.

No raptors are known to nest in the project vicinity: however, one species, Swainson's hawk (Buteo swainsoni) may migrate through the Tumwater Canyon area. Its period of migration occurs between May and early September (Wischnofske 1984).

Riparian Zone Habitat - Typical residents of the riparian zone include the river otter (Lutra canadensis), the beaver (Castor canadensis) and the mink (Mustela vision). Avian species such as the dipper (Cinclus mexicanus), bank swallow (Riparia riparia),

ruffed grouse (Bonasa umbellus) and McGillivray's warbler (Oporornis tolmiei) are typical.

No unique wildlife reside in the area.

Dryden Dam

Orchards which surround the project vicinity have modified the natural wildlife habitat of the area. The area falls within winter range for mule deer.

Small mammals occur in moderate to high densities. Rodents such as deer mice (Peromyscus maniculatus), voles (Lagurus spp.) and beavers are the most common inhabitants (Chelan Co. PUD 1980).

Riparian Zone Habitat - Deciduous shrubs which border the Wenatchee River and adjacent canal provide suitable wildlife habitat for birds and small mammals. As many as twenty bird species have been observed in the area (Chelan County PUD 1980). The most populus species are: American robin (Turdus migratorius), evening grosbeck (Hesperiphona vespertina), and red-winged blackbird (Agelaius phoenicus). Observed waterfowl include the mallard (Anas platyrhynchos) and the wood duck (Aix sponsa).

Although no nesting sites have been observed at the project site, the bald eagle is a recognized migratory species. The upland sandpiper (Bartramia longicauda) and long-billed curlew (Numenius americanus) also migrate to the area (Wischnofske 1984).

No unique habitats occur within the project site (Musser 1984).

Protected Wildlife Species

There are no known nesting sites of sensitive, threatened or endangered wildlife species in either of the project vicinities.

However, information obtained from the U.S. Forest Service and the Washington Department of Game indicates that several protected species may have transitory use of the riparian habitats.

Tumwater Falls

The species of concern include: Swainson's hawk (Buteo swainsoni); peregrine falcon (Falco peregrinus anatum); and bald eagle (Haliaeetus leucocephalus).

Swainson's hawks have been sighted at Winton and Coles Corner, 12 to 15 miles upstream. The hawks feed and rest on cut over forest land near Swiftwater picnic area.

The peregrine falcon may also reside in the cliffs and talus slopes of Tumwater Canyon. The nearest confirmed sighting of the peregrine falcon was at Rim Rock, approximately 72 miles south of the site.

Bald eagles have been sighted in the area since the canyon provides suitable feeding and roosting habitat. No nesting sites are known to occur in the area.

Dryden Dam

The bald eagle, a Federal-designated threatened species, over-winters along the lower Wenatchee River between November and June. Two other avian species, the upland piper and long-billed curlew, may also migrate to the area.

The spotted frog (Rana pertiosa) is another species which may inhabit the waters and banks of project area. None of these species are presently known to occur at the project site (Wischnofske 1984).

POTENTIAL IMPACTS

The proposed projects will not affect any unique wildlife habitats. Some riparian vegetation will be removed to permit access and construction of the proposed facilities. However, the areas of physical disturbance will be limited. At Tumwater Falls, 400 square feet of vegetation will be removed. At Dryden Dam, a total of 500 square feet would be affected.

Noise related to construction activities would, however, create some minor short-term effects. Construction would extend over a period of 3-5 months between the two sites.

Wildlife may be temporarily displaced to habitats more distant from the project sites, however, all of the effects are expected to be minor.

Since no nests of protected species are known to occur within the immediate vicinity of the proposed projects, no direct project effects are anticipated. Periods of noise and activity during construction will deter sensitive migratory species from using the area for approximately 3-5 months. These effects will be short term and minor.

MITIGATION

The only mitigation measure recommended at this time is that the disturbances to riparian habitat vegetation during site preparation and construction be minimized.

CHAPTER 5
FISHERIES

EXISTING CONDITIONS

Anadromous Fishery

The Wenatchee River provides passage, spawning, and rearing habitat for natural runs of anadromous salmon and Steelhead trout. The Leavenworth National Fish Hatchery (LNFH) on Icicle Creek supplements the local wild fishery populations with its production, primarily spring chinook salmon.

The Wenatchee River is one of the principal tributaries of the upper Columbia River and has played an important role in the maintenance of salmon and Steelhead runs within that portion of the Columbia River system, particularly after the construction of the Grand Coulee Dam. Anadromous fish which pass Rock Island Dam on the Columbia either proceed upstream along the Columbia and pass the Rocky Reach Dam or enter the lower Wenatchee, approximately 17.6 river miles downstream of Dryden Dam and 30.9 river miles downstream of Tumwater Falls. The known anadromous species consist of spring and summer chinook, sockeye and Steelhead trout. A run of coho salmon which had been supported by the Leavenworth National Fish Hatchery in the early 1970s has dwindled to the apparent status of a remnant run.

Spring Chinook Salmon (Oncorhynchus tshawytscha)

Spring chinook salmon constitute the major emphasis of the LNFH which has an annual production of about 2.5 million smolts of that stock. Naturally reproducing spring chinook spawn in Icicle Creek downstream of the LNFH and in Peshastin Creek. About 80 percent of the wild spring chinook spawning takes place upstream

of Tumwater Falls, particularly in the general vicinity of Wenatchee Lake. (Chelan County PUD 1983, Washington Department of Fisheries 1983.) While the Wenatchee River between Tumwater Falls and Dryden Dam is not a primary spawning or rearing area, its upstream tributaries are known to support both functions (Washington Department of Fisheries 1980). The most recent analyses indicate that approximately 5,600 adult spring chinook migrate upstream of the falls (Predesign Report). Known spawning areas are shown in Figure 5.

Adult spring chinook migrate upstream through the project vicinity between May and late June. Spawning occurs from mid-August through late September. Juvenile rearing occurs year-round with out-migration concentrated during April and May.

Upstream migration of adult spring chinook occurs during the peak flow period. Passage difficulty at Tumwater Falls result from the degraded condition of the existing fishway. The right wall of the fishway entrance has deteriorated over the years and allows spillway flows to inundate and compete with attraction flows at the fishway entrance. During high flow events, crashing flows create a barrier at the ladder entrance.

Summer Chinook Salmon (O. tshawytscha)

Summer chinook utilize the main Wenatchee River channel as their primary spawning habitat (Figure 6) (Hays 1984). Adult summer chinook arrive at the project areas from mid-June through mid-September and spawn from late September to late October. Fry emerge in late spring; juveniles rear from April through August and out-migrate between June and October.

Of the average annual 7000 summer chinook which run the Wenatchee system, approximately 30 percent of the summer chinook spawn below Dryden Dam, 60 percent between Dryden Dam and Tumwater Falls, and 10 percent upstream of Tumwater Falls, primarily in the four-mile reach between Lake Jolanda and the Highway 2 bridge over Chiwaukum Creek (Predesign Report). Early in-migration occurs with peak flows in the Wenatchee River following spring snowmelt. By the end of the upstream migration period, the Wenatchee typically has dropped to its annual low flow stage.

Sockeye Salmon (*O. nerka*)

Propagated at the Leavenworth National Fish Hatchery until 1965, sockeye salmon in the Wenatchee River are now sustained by natural spawning. In recent years, spawning of sockeye within the Wenatchee River system (Figure 7) is documented primarily in two major tributaries and one secondary tributary of Lake Wenatchee (Allen and Meekin 1980). The Wenatchee run is one of the two largest sockeye runs in the Columbia River system (15,000 to 50,000 fish), the other being the Okanogan/Lake Osoyoos run, and is the third largest in the State of Washington. Sockeye salmon in the Wenatchee River system comprise approximately 40 percent of the total sockeye production in the Columbia River system.

Adult sockeye migration occurs in the project areas from late July to mid-September. Spawning occurs during September. Juveniles rear year-round in Lake Wenatchee. Seaward migration of juveniles takes place during April and May.

Like summer chinook, sockeye encounter falling or minimum flows upon upstream migration. Nearly all of the sockeye run pass the project sites to spawn above Wenatchee Lake (Chelan County PUD 1980).

Steelhead Trout (Salmo gairdneri gairdneri)

Fish surveys conducted by the Washington Department of Game (unpublished) and the Chelan County PUD (1980) indicate that a relatively limited population of summer Steelhead occurs within the Wenatchee system, although a recent increase in adult returns coupled with a new conservative management strategy are hopeful signs of a return to a healthy run. Summer runs begin in early July with the majority of the Steelhead entering the Wenatchee in August, September and October. The Steelhead overwinter in the Wenatchee. A lesser proportion of the run overwinters in the Columbia River and enters the Wenatchee as water temperatures rise (Hays 1984). Spawning occurs from late March through early June with year-round rearing; however, locations are not known. Out-migration occurs in the spring.

Periodic restrictions on Steelhead fishing above Tumwater Falls have been imposed by the Washington Department of Game to encourage spawning escapement and reproduction. A new management strategy with a 20 percent harvest goal and an escapement goal of about 10,000 fish is expected to substantially increase average run size. In 1982, WDG and Chelan County PUD instituted a cooperative three-year pilot supplemental stocking program using a summer-run two-ocean Skamania stock. First returns are due in the summer of 1984 and expected survival is about 1 percent or about 1,000 fish (Hays 1984).

Other Anadromous Fish

Hatchery-supported runs of coho salmon in the Wenatchee River declined precipitously when culture of this species at the LNFH was curtailed in the early 1970s. Some sources indicate that very limited populations of coho salmon (0. kisutch) may persist in the project vicinity (WDF 1980) while other sources (Purdom

1984) have not observed evidence of spawning coho in the area since 1975.

Resident Fish

In addition to the anadromous species, the Wenatchee River also supports a population of resident rainbow trout (S. gairdneri), mountain whitefish (Prosopium williamsoni) and Dolly Varden char (Salvelinus malma). Planting of brown trout (Salmo trutta) was discontinued two years ago and there has been no evidence of significant survival or natural reproduction in the project areas (Chelan County PUD 1980).

Populations of mountain whitefish and Dolly Varden char appear to be thriving. Whitefish are year-round residents and the char spawn upstream (Chelan County PUD 1980),

Protected Fish Species

Spring and summer chinook salmon, sockeye salmon, Steelhead trout, rainbow trout, mountain whitefish and Dolly Varden char comprise the desirable species which spend a part of their life in the project vicinities. None of the species is a Federally-listed or a Federal-candidate rare, threatened or endangered species. The State of Washington has proposed that spring and summer chinook and Steelhead be classified as endangered on the Columbia River system. No species in the Wenatchee River are unique to the river system.

Effectiveness of Existing Passage Facilities

Numerous surveys, studies and projections have been conducted which address the status of the Wenatchee's anadromous fishery with respect to past management of the water resources. Construction of the Grand Coulee Dam initiated an effort to

maintain the salmon and Steelhead runs in the upper Columbia River system. The Wenatchee River is one of the four principal tributaries of the upper Columbia.

Since 1937, public agencies and private companies alike have expended substantial sums of money to maintain and improve the anadromous fishery. Projects have included the Leavenworth National Fish Hatchery, fish ladders and fish screens for power and irrigation diversion, and stream rehabilitation.

Previous diversions had reduced Wenatchee flows by up to 1,500 cfs at Dryden Dam and up to 1400 cfs at Tumwater Falls. Currently, the only diversion occurring at either of the project sites is the 200 cfs irrigation flow at Dryden Dam.

Fish ladder facilities at Dryden Dam and Tumwater Falls are functionally deficient due to: the occurrence of false attraction flows, insufficient pool volumes, designs which require intensive maintenance and provide reduced utility under continually changing flows.

False attraction flows exist at the Tumwater facilities. Migrating fish are not efficiently attracted to the ladder entrance. At Turnwater, the angled mid-section of the dam and discontinuities in the apron produce these false attraction flows.

At Dryden, a substantial proportion of migrating adult fish are attracted to the left bank where there is no fish ladder. Especially during lower flows, these fish are delayed in their upstream migration.

Both existing fish ladders are a weir and pool type construction which require manual placement or removal of stop logs to properly control water levels in the ladders. Caretakers do not

live on-site and proper operation of the ladders is a labor intensive effort. Flow regulation and sedimentation are major problems of the existing facilities (Predesign Report).

The weir and pool design of the existing ladders consists of a series of pools aligned in stairway configuration. As headwater varies, stop logs (weirs) are removed or replaced to lower or raise the level of the pool water, thereby maintaining flow through the ladder and, ideally, attracting fish at its base. Fluctuations in flow can seriously affect the utility of such a system that is only periodically maintained.

POTENTIAL IMPACTS

Potential fishery impacts for the project include short-term effects during construction and long-term improvements in the fish passage facilities. Short-term effects involve potential increases in turbidity or sedimentation, or impacts to the run due to temporary passage facilities.

Most water quality effects have been mitigated through design and through construction methods. Instream turbidity and sedimentation will be controlled by the use of cofferdams and waterproof membranes on the outside of the cofferdams. This is further described in the chapter on Water.

Temporary fish passage will be provided to eliminate impacts to migrating adults during construction. This is further addressed in the Predesign Report.

Long-term impacts are expected to be positive. New facilities as designed are expected to:

- Pass fish more effectively
- Reduce passage delay, injury and stress on fish
- Permit more fish to reach preferred spawning grounds in better condition
- Preserve the vigor of migrating fish during normal and adverse water years
- Create facilities which operate more effectively over a wider range of flows
- Improve run strength, size and vigor

These net benefits are discussed thoroughly in Chapter 9 of the Predesign Report.

MITIGATION

Mitigation for ladder construction has already been programmed into construction methods and schedules. Construction timing will be planned to not coincide with peak run events. Water quality degradation will be carefully controlled as described above. Temporary passage will be provided as described in the impacts section above and in Chapter 8 of the Predesign Report.

The projects are expected to benefit both local and regional fisheries. As such, they serve as mitigation for other negative effects on the fishery in the Columbia Basin.

CHAPTER 6
HYDROLOGY

EXISTING CONDITIONS

The Wenatchee Basin

The headwaters of the Wenatchee River emanate from Lake Wenatchee (elevation 1550 feet) which is principally fed by the White River and the Little Wenatchee River. From Lake Wenatchee, the Wenatchee River flows south approximately 18 miles to Tumwater Canyon and the Tumwater Falls fish ladder.

Tumwater Canyon continues downstream approximately 3.5 miles until it emerges to flow southeast into an irrigated valley. Another mile downstream, an important tributary, Icicle Creek, joins the Wenatchee. The Leavenworth National Fish Hatchery is located on Icicle Creek one mile upstream of the confluence. Other minor tributaries and water diversions occur in the area, however, their effects or contributions to the projects under discussion are minor.

Dryden Dam is located on the Wenatchee River approximately 9 miles downstream of the mouth of Icicle Creek. The irrigation canal which is located at the left abutment diverts up to 200 cfs from the Wenatchee during the summer and fall. Dryden Associates have been issued a Preliminary Permit by the Federal Energy Regulatory Commission to pursue development of hydropower. The diversion could reduce flows for one mile downstream of the dam.

Tumwater Falls

Data from three USGS gaging stations, shown in Figure 1, were correlated to determine the hydrology at Tumwater Falls. Comparison of the USGS gage records on Icicle Creek, and on the

Wenatchee River at Plain (RM46.2) and Peshastin (RM21.5), indicate that the flow at Tumwater Falls is 4 percent higher than the Plain gage flow 15.3 miles upstream. The Peshastin flows are 6 percent greater than the sum of the flow from Icicle Creek and the flow at Plain due to input from Chiwaukum Creek and several smaller tributaries.

Seasonal variations in flows at each of the gages had only a minor effect on the accuracy of the correlation. A computer program developed by OTT known as FLODUR was used to correlate 62 years of mean daily flow data (USGS tape). Figures 8 and 9 show the resultant hydrograph and flow duration curve at Tumwater Falls (Predesign Report). Mean annual flows were computed to be 2,372 cfs at Tumwater Falls.

The hydrograph (Figure 8) shows that the peak flow occurs during May and June during spring melt-off at the highest elevations. Low flows occur in September. Figure 9 shows that for 60 percent of the average year flows at Tumwater exceed 1000 cfs. Figure 10 displays a detailed hydrograph at the site during a typical water year (1969).

Dryden Dam

Peshastin gage is 3.9 river miles upstream of Dryden Dam. Below Peshastin gage, Peshastin Creek adds additional flow to the Wenatchee River. This flow was estimated by Chelan County PUD (1980a) to be 2.5 percent of the' Wenatchee River flow at Peshastin. USGS data from Peshastin gage, between 1930 and 1981 were corrected by the 2.5 percent and used to produce a mean monthly hydrograph, Figure 11, and a flow duration curve, Figure 12, for the Wenatchee River at Dryden Dam. These figures were also produced using FLODUR. Flow data from a typical water year 1969, is shown on Figure 13. Mean annual flow at Dryden Dam has been computed to be 3,212 cfs.

Like Tumwater peak flows occur during May and June. Low flows are typical in September. At Dryden, flows typically exceed 1350 cfs for 60 percent of the year.

Water Uses

Hydroelectric Power

Preliminary permits for hydroelectric development have been issued in the past at both project sites.

In 1978, Chelan County PUD initiated redevelopment of the Tumwater Falls project. After receiving a Preliminary Permit and conducting initial investigations, Chelan County PUD discontinued redevelopment efforts in 1981 since the project was, in their estimate, not economically feasible at the time. Since Chelan County PUD's surrender of the Preliminary Permit, competing permits have been filed on the site by Hydro Energy Associates and by the City of Sultan, Washington. At the writing of this report, no Preliminary Permit has been issued.

After power production was terminated in 1957, Chelan County PUD considered redevelopment of Dryden Dam for hydropower between 1962 and 1965, and again between 1978 and 1981. Both redevelopment efforts were abandoned as not being cost effective at that time. After Chelan County PUD's surrender of the Dryden Preliminary Permit in 1981, Dryden Associates filed for a Preliminary Permit on the site. This Preliminary Permit was issued in 1983.

Irrigation

Dryden Dam was built in 1907 to divert irrigation water into the Highline Irrigation Canal. The existing fishway is located on the right bank adjacent to the trash sluice. The canal intake,

gate house and second trash sluice are at the left bank. The canal cross-section is trapezoidal with flow regulated by three steel gates beneath the gate house. The capacity of the canal is estimated to be about 500 cubic feet per second (cfs) (Chelan County PUD 1980); it has degraded from its original capacity of 1500 cfs. The canal length is approximately one mile, extending to the old powerhouse site and irrigation diversion. The Wenatchee Reclamation District currently maintains the water right for 200 cfs which Chelan County PUD is obligated to supply.

POTENTIAL IMPACTS

The proposed projects will not alter or affect the hydrology of the area. The hydrologic conditions immediately surrounding the construction site will be affected during the dewatering phase. At Tumwater Falls, localized areas will be dewatered for up to 3.5 months. At Dryden Dam, dewatering will occur for 5 months.

The schedule and delivery of irrigation water will not be affected by the construction or operation of the proposed fish ladder at Dryden Dam.

Project construction and operation are not expected to affect future feasible hydroelectric development at the sites. Effective fish passage will be the priority of the project, however, hydropower applicants will continue to be informed of the project progress and final design.

MITIGATION

No mitigation measures are expected to be necessary.

CHAPTER 7
WATER

SURFACE WATER QUANTITY

EXISTING CONDITIONS

Surface water quantity for both sites has been described in the Predesign Report for the projects. Mean annual flow is 2,372 cfs at Tumwater and 3,212 cfs at Dryden. Monthly flows are shown in Figures 8 and 11. Average year low flows are approximately 750 cfs at Tumwater Falls and 1000 cfs at Dryden Dam. The current fish ladders pass an undetermined amount of flow at both sites. The new ladders will be designed to pass flows on the order of 180 cfs at Tumwater and 150 cfs per ladder at Dryden.

POTENTIAL IMPACTS

The only potential impacts are effects on competing water uses. At Tumwater, hydroelectric development may occur in the future. At Dryden, this is also the case and, in addition, irrigation is a competing use. Irrigation utilizes 200 cfs during the summer months which is diverted via the canal on the left bank. Construction at Dryden will be carried out so as not to block the canal or interfere with irrigation flow during the summer months. The ladder projects will provide water which is also applicable to instream flows for fish and therefore is unlikely to compete with hydropower water use to any significant extent.

MITIGATION

Other than designing the projects to preserve irrigation flows, no mitigative measures are needed.

SURFACE WATER QUALITY

EXISTING CONDITIONS

Water quality in the Wenatchee River near the project sites is generally good to excellent. The Washington Department of Ecology has classified the area near Tumwater as Class AA waters and the area near Dryden as Class A waters. Class AA represents superior water quality, while Class A represents excellent water quality. Washington water quality standards for these classes are shown in Table 1.

Table 2 shows mean, maximum and minimum water quality readings over the period 1970-1979. The Leavenworth data is considered nearly representative of the Tumwater site. Mean water temperature at Tumwater Falls is 2.5°C colder than that at Dryden Dam and is slightly less alkaline. Turbidity is higher at Dryden but is still well within standards. Conductivity is considerably higher at Dryden, but dissolved oxygen is similar at the two sites, and is typically near saturation level. Phosporus is similar at the two sites, while nitrogen is higher at Dryden, although still low. Coliform bacteria are considerably higher at Dryden, probably due to septic tank and/or sewage system discharges from Leavenworth and/or Peshastin. The higher temperature and nutrient concentrations at Dryden indicate a better probability for a well-developed aquatic ecosystem (and hence fish food supply) at that site.

POTENTIAL IMPACTS

Water quality impacts from the projects could result from:

- Discharge of soils or sediments during construction
- Leaching of concrete
- Leakage of gasoline, oil or other materials from vehicles on site

Table 1. Washington Water Quality Standards for Class AA and A Waters (Source: Washington Department of Ecology 1982)

	Class AA	Class A
Dissolved Oxygen	Shall exceed 9.5 mg/l	Shall exceed 8.0 mg/l
Total Dissolved Gas	Shall not exceed 110 percent of saturation	Shall not exceed 110 percent of saturation
Temperature	Shall not exceed 16.0°C. If natural conditions exceed 16.0°C increases shall be less than 0.3°C	Shall not exceed 18°C. If natural conditions exceed 18°C, increases shall be less than 0.3°C
pH	Shall be within the range of 6.5 to 8.5 with man-caused variation less than 0.2	Shall be within the range of 6.5 to 9.0 with man-caused variation less than 0.5
Turbidity	Shall not: exceed 5 NTU over background if background is less than 50 NTU OR increase more than 10 percent if background turbidity is greater than 50 NTU	Shall not: exceed 10 NTU over background if background is less than 50 NTU OR increase more than 20 percent if background turbidity is greater than 50 NTU
Coliform Bacteria	Fecal coliform shall not exceed 50/100 ml and less than 10 percent of the samples shall exceed lOO/lOO ml	Fecal coliform shall not exceed lOO/lOO ml and less than 10 percent of the samples shall exceed 200/100 ml

Table 2. Summary of Water Quality at Leavenworth
(Source: Washington Department of Ecology 1977)

	Mean	Maximum	Minimum
Temperature °C	4.45	14.0	0.1
Turbidity (NTU)	2.82	8.0	1.0
Color (units)	15.4	25.0	4.0
Conductivity (umhos)	36.0	49.0	27.0
Dissolved oxygen (mg/l)	12.4	14.7	10.0
pH (units)	7.31	7.9	7.0
Ammonia Nitrogen (mg/l)	0.03	0.07	0.02
Nitrite-Nitrate Nitrogen (mg/l)	0.04	0.61	0.00
Total Phosphorus (mg/l)	0.01	0.04	0.00
Total Coliforms (#/lOO ml)	51.9	160.0	12.0
Fecal Coliforms (#/l00 ml)	2.42	16.0	2.0

Summary of Water Quality Data Near Dryden
(Source: Chelan Co. PUD 1980)

Temperature °C	6.9	14.60	0.30
Turbidity (NTU)	4.0	8.0	1.0
Color (units)	16.5	25.0	8.0
Conductivity (umhos)	50.8	86.0	33.0
Dissolved Oxygen (mg/l)	12.2	14.4	9.6
pH (units)	7.4	8.1	6.9
Ammonia Nitrogen (mg/l)	0.04	0.07	0.02
Nitrite-Nitrate Nitrogen (mg/l)	0.06	0.12	0.02
Total Phosphorus (mg/l)	0.01	0.04	0
Dissolved Phosphorus (mg/l)	0.0006	0.01	0
Total Coliforms (#/l00 ml)	190.5	1000.0	40.0
Fecal Coliform (#/100 ml)	7.7	22.0	0

In addition, alteration of sediment dispersal patterns could potentially cover otherwise clean gravels downstream of the projects. Impacts will be minimized by the construction of cofferdams and dewatering prior to ladder construction. Concrete work will be carried out in dewatered areas. The stream side of earthfill cofferdams will be covered by a synthetic membrane. It is inevitable that a limited amount of sediment will enter the stream. However, impacts from this are expected to be minor, provided that proper construction procedures are followed.

Oil, gasoline or other petroleum residues are unlikely to spill into the river directly due to dewatering procedures. Any oil spilled on the construction site may eventually leach into the river; however, risk of a spill of any major quantity is unlikely.

From the water quality data in Table 2, it is clear that water quality levels are within standards for Class AA waters for Tumwater and Class A water for Dryden for all parameters, except fecal coliforms which periodically violate the standards. Since the sampling point for Tumwater may have been below Leavenworth, the water quality at Tumwater Falls may be somewhat better than indicated by the data table. The projects should cause no change in fecal coliform organisms provided that temporary sanitary facilities during construction are self-contained.

MITIGATION

A number of mitigative measures to ensure conformance with water quality standards have already been included in the proposal. These include:

- Dewatering of fish ladder area prior to construction
- Timing construction to avoid high water conditions

- Placement of non-erodible waterproof membrane on outside of cofferdams
- Restabilizing and revegetating streamside areas as soon as construction is completed
- Hauling of excavated materials off-site on a periodic basis
- Removal of cofferdam material off-site if it contains substantial amounts of fine sediments
- Rapid backfilling of spoil material as particular project segments are completed
- Timing construction to be compatible with irrigation withdrawals via the canal
- Placement of concrete will not occur in flowing water without adequate protection against leaching

GROUNDWATER QUANTITY AND QUALITY

EXISTING CONDITIONS

Little information exists on local groundwater characteristics other than water well logs (U.S. Department of Interior 1979) and generalized descriptions of aquifers (Foxworthy 1979, Martin 1981). Data from these sources has been used to compile data for this section.

Wells in the project areas vary from dug wells 15 feet or less in depth to drilled wells 25 to 100 feet deep. There are no wells recorded closer to Tumwater Falls than the Leavenworth area, but wells are found from Leavenworth to Dryden. Water yields around Leavenworth vary from 9 to 90 gallons per minute with similar yields near Dryden, except for one well yielding 225 gallons per minute near Peshastin.

The area has no major groundwater depletion problems (Martin 1981). Wells are found only in the river valley and are scattered using only a small total yield compared with probable

groundwater sources. Most groundwater gradually travels down the Wenatchee Valley as groundwater or emerges as surface flow from springs. The portion that remains as groundwater feeds the Columbia Plateau Groundwater Reservoir.

POTENTIAL IMPACTS

The projects will not use water consumptively. Only surface water will be used for the fish ladders and attraction flows. There will therefore be no effect on groundwater.

MITIGATION

No mitigative measures are needed for groundwater.

FLOODING

EXISTIING CONDITIONS

The Wenatchee River flow peaks annually at 10,000 to 15,000 cfs. The dams operate as uncontrolled spillways and provide no flood storage. The existing ladders are completely within the normal river floodplain.

POTENTIAL IMPACTS

The new fish ladders will be designed to operate at river flows between 10,000 and 12,000 cfs, providing a much wider operation regime than the existing ladders. High flood flows will inundate the downstream entrance pools but will not damage the ladder which will be designed to withstand the loo-year event. All portions of the ladder facility will lie within the floodplain.

MITIGATION

The ladder will be designed to withstand peak flood flows. It will also operate over a considerably wider range of flows than the present structures. There is no need for other mitigative measures.

CHAPTER 8
AIR QUALITY

EXISTING CONDITIONS

The air quality at both Dryden and Tumwater is rated as excellent by the Washington Department of Ecology. There are no registered emissions sources closer than Cashmere, roughly 20 miles east of Tumwater Falls and 7 miles east of Dryden Dam. At Cashmere, there are two lumber plants producing minor air emissions from hog fuel boilers and other minor sources. Further east at Wenatchee are a concrete plant, a sand and gravel operation, and grain operation which also produce minor emissions. These sources contribute minor amounts of particulates, sulfur dioxide and nitrogen oxide to the atmosphere (Washington Department of Ecology 1982). However, the project areas have no sources of significant emission and pollutant levels are well below criteria levels for both State and National standards.

The closest air quality monitoring station is located at Wenatchee 17 miles east of Dryden and 30 miles east of Tumwater Falls. This station monitors only particulates. During 1983, levels averaged 56 mg/m3. During 1982, the annual mean level was 34 mg/m3 (Washington Department of Ecology 1983). No data on gaseous pollutants exists for the area due to a lack of monitoring stations.

POTENTIAL IMPACTS

The fish passage facilities projects will cause no permanent or long-term effects on air quality. The project operations will involve no air pollutants. There will be minor increases of particulates during construction from earth moving activities, including site clearing, grading and cofferdam construction.

Some wetting of construction areas may be necessary to control dust and protect nearby orchards. Minor emissions of sulfur and nitrogen oxides from construction vehicles can be expected. All of these increases will be temporary in nature and will not cause any violations of standards.

MITIGATION

No mitigative measures are necessary.

CHAPTER 9
SOLID AND HAZARDOUS WASTE AND TOXIC MATERIALS

EXISTING CONDITIONS

The area presently has no known problems with solid or hazardous waste or toxic materials. Washington Department of Transportation periodically removes sand and gravel from the pit adjacent to the Dryden site, but this material is non-toxic.

POTENTIAL IMPACTS

The projects will generate no hazardous waste or toxic materials. Both projects conform with the Chelan-Douglas County Comprehensive Solid Waste Management Plan (Chelan and Douglas Counties Planning Commissions 1982). Potential leaching of cement into the Wenatchee River will be controlled by cofferdams and by performing work in the dry during relatively low flows. Sanitary waste generate< during the construction period will be retained in self-contained facilities and removed from the site. No toxic materials will be used on the site.

MITIGATION

Aside from normal and planned construction practices discussed above, no mitigation is necessary.

CHAPTER 10
TOPOGRAPHY, GEOLOGY AND SOILS

EXISTING CONDITIONS

Tumwater Dam is located at elevation 1487 on the east side of the Northern Cascades Physiographic Province (Franklin and Dyrness 1971). The site is near the lower end of Tumwater Canyon, a steep-sided canyon formed by eastern Cascade foothills and cut by the eastward flowing course of the Wenatchee River. The river gradient is relatively steep throughout the canyon with an average gradient of 1.5 percent near the project site.

Geologically, Tumwater Canyon was formed by river and glacial cutting and to some extent by upthrusts of intrusive rock. The project area is dominated by rocks of the Mount Stuart Batholith which is an intrusive rock mass of Mesozoic age. This mass intrudes older rocks of volcanic and metamorphic origin (de Rubertis 1983). Geological mapping by the U.S. Geological Survey show the several areas to be comprised of undifferentiated Pre-tertiary rocks, including schist, granodiorite, quartz diorite and serpentine (Whetten 1980a). The river bed contains some alluvial material of Quaternary origin and has been confirmed by field investigation. De Rubertis (1983) has found this material to include fine and coarse alluvium, particularly behind Tumwater Falls Dam, with larger colluvial materials and manmade fill under and around the structure.

Exposed bedrock at the site is diorite. Alluvial and colluvial material5 generally overlie this bedrock to depths of approxi-mately 10 to 20 feet, due to the steep gradient of the river in this section. The fill material is located near the dam and along and under State Highway 2. This material is thought to be amphibolite from nearby quarries in Leavenworth (de Rubertis 1983).

The nearest fault is the Leavenworth fault located one mile north of the site. The fault marks the western boundary of the Chiwaukum Graben (Whetten 1980a). The history of the site indicates that earthquake activity has been minor, and the dam shows no obvious damage from past earthquakes (de Rubertis 1983).

The Tumwater site is slightly beyond the boundaries encompassed by the Chelan County Soil Survey (U.S.D.A. 1969). A comparison of soil types listed in the survey with site characteristics indicates that the Tumwater site falls within Type 9, which is the Rock Outcrop-Rock Land-Terrace Escarpments Association. This association is composed of steep, to very steep, to nearly vertical areas of rock outcrops covered by shallow to very shallow soils over rocks and terrace breaks.

Dryden Dam is located in a broad floodplain area of the Wenatchee River. It is flanked by low foothills to the north, but to the south the floodplain comprises a relatively flat area beyond the river banks. River gradient is considerably lower at Dryden with an average gradient of less than one percent.

The Dryden area is dominated geologically by alluvial influences. The broad floodplain has deeply buried the bedrock which is exposed in only a few places near the project site. Exposed bedrock, just upstream from the dam on the left bank, is of the Swauk formation, an arkosic sandstone of fluvial origin which is believed to be Cretaceous-Paleocene in age. Bedrock from the surrounding foothills dips steeply beneath the valley surface and is not exposed at the project site (de Rubertis 1983). Previous borings by Chelan County PUD near the site indicate about 100 feet of alluvium overly bedrock.

Mapping by the U.S. Geological Survey indicates that the entire floodplain near Dryden is Quarternary alluvial material.

Surrounding valley sideslopes are Tertiary conglomerate sandstone, mainly from the Chumstick formation. These formations are thick-bedded sandstones mixed with minor shales and with pebbles of dacite, gneiss and rhyolite at the base of the beds (Whetten 1980b).

The site lies within an area characterized by the U.S. Army Corps of Engineers as having potential for minor earthquake damage. The existing Dryden Dam has survived a number of small earthquakes without apparent damage (de Rubertis 1983). U.S.G.S. mapping (Whetten 1980b) shows no faults on the northern foothills adjacent to the project nor in the floodplain, although there are some minor faults shown over a mile to the south on foothills across the valley.

Soils at the Dryden site are of the Burch-Cashmont Association. These are medium and moderately coarse textured soils, located on level or sloping terraces, alluvial fans and footslopes. Soil types at the site are (right bank) Beverly fine gravelly sandy loam upstream of the proposed ladder location, Pogue very stony fine sandy loam at the ladder location and Burch fine sandy loam immediately downstream. Soil types on the left bank have been mapped as the miscellaneous land-type, Terrace Escarpments (U.S.D.A. 1969). Imported fill material is also present on both banks as part of a gravel pit operation on the right bank and as fill for the railroad and gate house on the right bank.

POTENTIAL IMPACTS

Impacts on existing topography will be negligible. Minor cuts and fills on the slopes next to the fish ladders are the only topographic modification. These will both be less than 15 feet in height and will represent only a minor horizontal change to the existing slopes.

There will be no significant modification to underlying or exposed geological features at either site. Minor cuts into bedrock may be required to expand the existing ladders or to install the new left bank ladder at Dryden. These cuts will cause no detrimental effects on site or regional geology.

Soils and sediments will be altered slightly by the projects at Tumwater Falls. Excess soil will be removed from the sites and disposed in an approved manner. Disturbed sediments will be redistributed by the river after construction. However, no major or long-lasting effects are anticipated.

MITIGATION

No mitigation is necessary for topography, geology or soils.

CHAPTER 11
CULTURAL AND HISTORIC RESOURCES

EXISTING CONDITIONS

The purpose of this section is to determine the cultural and historic significance at the sites of the proposed fishways.

In terms of cultural concerns to date, no data exists concerning archaeological resources at the proposed sites. Since the proposed fishways will be built where previous excavation has taken place, it is doubtful that any significant archaeological resources do exist. Bonneville Power Administration will conduct a cultural site survey prior to construction if determined necessary.

Both the Colville and Yakima Tribes have had historical settlements in the Wenatchee Basin. The tribes both have interest in the sites based on ceded lands in the vicinity (Vogel 1984). A cultural resources survey will be conducted prior to any clearing or construction activity. Any cultural artifacts discovered will be removed by a Washington State Certified Archaeologist prior to commencing construction work. If artifacts are discovered during construction, work will be halted in the applicable areas until such artifacts can be professionally removed.

The dam structures will not be detrimentally affected by the fish ladder construction. Historical values of the dams and of the gate house at Dryden will remain intact. The projects will affect the general fishery in the Columbia Basin in which both tribes have fishing interests. The affects on the fishery are expected to be positive for tribal use as well as for sport and commercial uses (Predesign Report).

Both Tumwater Falls and Dryden Dam were built in the early 1900s. The existing facilities at both sites have the potential for historic significance, but have not been designated for protection.

POTENTIAL IMPACTS

During excavation, there is the potential for the disturbance of archaeological resources at both sites. As indicated, there is little likelihood that such resources exist.

MITIGATION

A cultural site survey will be carried out prior to construction if BPA considers it necessary. Any resources at both Tumwater Falls and Dryden Dam which are found to have the potential for historic or cultural significance will be removed prior to construction of the proposed fishways. The gate house at Dryden Dam will not be disturbed by construction activities.

CHAPTER 12
RECREATION

EXISTING CONDITIONS

Introduction

The area in which the Tumwater Falls and Dryden Dam sites are located is very popular for recreational activities (Figure 14). The Wenatchee River is used for a variety of water-related recreation and the lands around the Tumwater Falls and Dryden Dam sites are used for many year-round recreational activities. Tourism in the region is popular and increasing. Tumwater Canyon is a designated recreational use area. The Wenatchee Valley near Dryden Dam consists primarily of privately owned orchard lands.

Regional Activities

Recreation is a major land use in the vicinity of Tumwater Falls and Dryden Dam. The comprehensive plans of the area encourage recreational growth. The long-range plans of the Forest Service are to improve existing recreational facilities and to establish new sites.

The Wenatchee River is well known for its white water rafting. Approximately 50 percent of Washington State commercial river rafting takes place on the Wenatchee River between Leavenworth and Wenatchee River County Park near Monitor (Chelan County PUD 1980). For optimum white water rafting, a minimum of 2300 to 3000 cfs is needed in that section of the Wenatchee River. This range of flow occurs between the months of April and June. The Wenatchee River is also used for kayaking and tubing. Fishing is very popular along accessible reaches of the Wenatchee River.

There are no designated swimming areas on the Wenatchee River around Tumwater Falls and Dryden Dam. However, unauthorized swimming does occur.

Camping is a popular form of recreation throughout Chelan County. Camping areas which are privately owned or Federally administered are scattered along the Wenatchee River and its tributaries, such as Icicle Creek. Several camping areas are also located around Wenatchee Lake and Fish Lake, while others are along the main river. The closest, Tumwater Campground, is located at the northern end of Tumwater Canyon with another located east of Leavenworth. Rock climbing, hiking, horseback riding, picnicking, and sight-seeing are popular along the Wenatchee River, its tributaries and designated areas, and on undeveloped lands.

Hunting is also a popular recreational sport in the vicinity of Tumwater Falls and Dryden Dam. The Forest Service and the Washington State Game Department, and several other agencies are working on a specific plan for hunting in eastern Washington which will designate game management units. Generally, bow and arrows, muzzler loaders and modern rifles are used to hunt deer, elk, and other mammals in the vicinity of Tumwater Falls and Dryden Dam. However, elk are not as abundant around Dryden Dam. Grouse are hunted around Tumwater Falls and chukarr quail, and pheasants are hunted around Dryden Dam (Musser 1984).

State Highway 2 is considered a State Scenic and Recreation Highway which has a setback requirement to create an open space effect (Chelan County Regional Planning Council 1973). Several pulloffs are provided along this highway which enable tourists to access the sites. One pulloff north of Tumwater Falls includes a picnic/day-use area.

Winter recreation in the vicinity of Tumwater Falls and Dryden Dam includes snowmobiling, cross-country skiing, snowshoeing and inner tubing. A winter recreation area is located just north of Leavenworth. Although winter recreation is popular, most of the tourists come for the summer recreational activities.

Tourism is very popular around the project sites. The tourist season spans the months of June, July and August. The tourists are often day visitors from the Puget Sound area. Overnight visitors stay in campgrounds or nearby motels. Tourism during the summer months accounts for more than half the seasonal population in the vicinity of Tumwater Falls and Dryden Dam. Tourists come to enjoy the many recreational opportunities in the area and contribute significantly to the regional economy. The Bavarian theme in the community of Leavenworth attracts many visitors year-round. Leavenworth has several motels, a campground, a golf course, and a park on the river. Leavenworth National Fish Hatchery also attracts many tourists especially in mid-August during spawning season.

Tumwater Falls

Tumwater Falls and Tumwater Canyon are popular recreational use areas. The closest campground to the site is Tumwater Campground which is 9 miles northwest of Leavenworth. Two miles south of Tumwater Campground is Swiftwater picnic area. The Tumwater Botanical Area is south of the picnic area and north of Lake Jolanda. It has unusual and natural plant life found only in that area. The Alps Gift Shop, located on Lake Jolanda just north of the site, is a popular place for tourists. Many visitors come to view the falls and the existing fish ladder at the site. Several pulloffs on Highway 2 in the canyon provide access to the river. Kayaking is popular in Tumwater Canyon, south of Tumwater Falls, and rock climbing is done on Castle Rock which lies along the southeast side of the canyon. The bridge

once used to carry the Tumwater Falls Dam penstock across the river to the old powerhouse now provides foot access to the right bank of the river.

Dryden Dam

Dryden Dam is not located in a recreational use area, though there are some recreational uses. Commercial white river rafters often break for lunch at the DOT gravel pit located on the right shore of the dam (Chelan County PUD 1980). When flows in the Wenatchee River exceed 7000 cfs, rafters float over the weir: but, usually they remove their rafts and carry them around the site. Tubing and swimming occur at the site, although there is no designated area for this. Field sports are popular at the Dryden Field. The closest campground is just east of Leavenworth.

POTENTIAL IMPACTS

During construction, impacts will include the interruption of recreational activities at the sites. This is not a significant problem because neither of the sites have any developed or specific recreational uses where the construction will occur. At the Dryden Dam site, river rafters will not be able to float their rafts over the weir during construction. the annual low flows which discourage rafters from floating over the weir coincide with the period of construction. Fishing and swimming at both sites will not be possible during construction. After construction, it is expected that more visitors will be attracted to view the fish passage through the facilities. The proposed Tumwater Falls and Dryden Dam facilities will improve the recreational fishing both at the sites and regionally.

MITIGATION

The proposed projects at the Tumwater Falls and Dryden Dam sites will not alter the dams. Walkways will be provided at both sites to view the facilities. Access will be provided at Dryden Dam for white water river rafters to carry rafts around the construction site.

CHAPTER 13
NOISE

EXISTING CONDITIONS

Noise at the sites is generally related only to vehicular traffic and natural background noise of flowing water and wildlife. Human presence at both sites is minor, consisting at most of a few carloads of tourists or picnickers. No noise measurements were taken for this study, however, river noise is estimated to be 70 to 80 decibels from the banks at both sites. Dryden has little normal traffic flow by the site, however, Tumwater Falls is situated on the main highway and receives periodic noise of 90 to 110 decibels from passing vehicles.

POTENTIAL IMPACTS

Noise levels will be somewhat elevated at each site during the construction period. Washington State has no noise standards for temporary construction related effects. Except for farmhouses located a few hundred feet or more from the Dryden site, there are no regular receptors likely to be affected by noise levels. Construction at each site is expected to last only 3 to 5 months. Noise levels following construction and during operation will not change from existing levels.

MITIGATION

No mitigation for noise effects are necessary.

CHAPTER 14
AESTHETICS

EXISTING CONDITIONS

Regional

The vicinity of Tumwater Falls and Dryden Dam is known for its scenic attractions. The many lakes, the Wenatchee River, and its tributaries create the natural settings enjoyed by many visitors. The Wenatchee River has a strong visual impact due to the patterns and textures created by the changing flows, pools, riffles and falls.

The abundance of undeveloped land around Tumwater Falls and Dryden Dam offers a unique visual character to the elements of form, line, color and texture. The development that currently exists has created features which add interest to the natural environment. The community of Leavenworth is an example of this. The Bavarian architecture creates lines and color which have been designated to blend with the existing natural surroundings.

Tumwater Falls

The Tumwater Falls site is located within what is considered by the National River Inventory as "spectacular Tumwater Canyon." Tumwater Canyon is located on the Eastern Cascade foothills and has a ponderosa pine-mixed conifer type of vegetation. The canyon is rated as having "outstandingly remarkable" values for its scenic characteristics.

The Tumwater Canyon has a high scenic value due to the diversity and variety of the landscape. Both characteristics are found in the steep slopes of the canyon and in the rock outcrops along the

canyon walls. The range of vegetation types and the past logging activites have produced patterns on and above the canyon walls. The Wenatchee River also adds to the diversity and variety of the Tumwater Canyon.

The steep canyon walls and winding river limit the viewing range from the Tumwater Falls site. The dominant features at the site are the dam and old caretaker's house. The dam adds strong horizontal lines to the natural setting. Highway 2 skirts the site and provides a viewing point of the falls and the old caretaker's house. The existing structures have weathered and add character to the natural surroundings.

Dryden Dam

The Dryden Dam site is not considered an outstanding scenic value but is described as "rural and pleasant" (Chelan County PUD 1980). Dryden Dam is located in an area of rolling plateau lands with high desert shrub type of vegetation. The moderately sloping hills provide the viewer with an expansive viewing distance, which includes a view of the Cascade Range to the northwest.

Vertical elements are the strong focal points in this landscape. The strongest visual elements are the patterns of the orchards. The visual impact of the orchards depends to a great extent on the time of the year. The Wenatchee River is also a strong focal point, adding variety to the landscape.

The main visual features at the Dryden Dam site are the dam and gate house. The canal, which parallels the river, can only be seen at a close distance. Burlington Northern Railway, located on the left bank of the site, and nearby utility poles add vertical and horizontal lines to the existing landscape. The site cannot be seen from any major roadways. However the entire Dryden Dam site can be seen from an orchard owner's residence located directly above the site on the left bank.

POTENTIAL IMPACTS

The visual impacts at the sites will occur mainly during the period of construction. Tumwater Falls is located on a relatively populated highway (Highway 2). Construction at the site will be visible from this highway. After construction, the only major changes will be the removal of the old caretakers house and the additional parking spaces. However, this is not expected to have a significant adverse visual impact.

The Dryden Dam site is not located in a popular area so visual impacts will be minimal. However, construction will be seen from the house located above the site on the left bank. After construction, the only significant change will be the new fish ladder on the left bank; this will not have any adverse visual impacts.

MITIGATION

Visual impacts will be most evident during construction, however, the effects are not expected to be significant and no mitigation measures are recommended.

Post-construction effects related to aesthetics will be minor. The project design will not be significantly different from the existing facilities in visual quality. Slight changes in color and texture will weather to blend with existing structures and the ladders will be designed to be as visually appealing as possible.

CHAPTER 15
ECONOMICS

EXISTING CONDITIONS

Chelan County supports a rural residential community with primary workers employed locally (Washington Department of Research and Statistics 1980a and 1980b). In 1978, personal per capita income for the county was $9,181; slightly higher than the State's average of $8,553. Personal income is derived from the following sources:

Agricultural	17.9%
Nonagricultural	67.3%
Public Sector	14.8%

(U.S. Department of Commerce, 1978)

The economy of Chelan County is largely based upon fruit production; however, the provision of raw materials for the lumber and wood products industry is also important (Washington Research and Statistics Office 1984).

In 1983, the County average annual unemployment rate was 15.8 percent. The area employment typically fluctuates on a seasonal basis with the lowest unemployment occurring between April and October (Office of Research and Statistics 1984).

POTENTIAL IMPACTS

The projects are not expected to create any negative impacts to the local economy, however, the projects will supply local communities with increased revenue during the period of construction.

Commercial rafters may be inconvenienced by the land carriage of their equipment around Dryden Dam, but this is a fairly normal procedure for them. The project is not expected to deter their customers from the excursion.

Short-Term Impacts

Preliminary capital cost estimates for construction are $642,000 at Tumwater Falls and $689,000 at Dryden Dam. It is likely that a substantial portion of the labor and materials will be available locally. The project could supply up to 33 skilled and unskilled individuals with three to five months of full-time employment. Local services may also benefit from the influx of outside revenues and imported manpower.

Long-Term Impacts

Responsibility to oversee the long-term operation of the facilities would belong to Chelan County PUD. Employment related to annual operation and maintenance cost are not considered here since such costs may be incorporated into an existing position.

The improved operation of the fishway is also expected to attract increased numbers of fishing enthusiasts and recreationists to the area which would further enhance the demand for and use of local services. Local motel, restaurant, and retail services could benefit from the increases in visitor use of the area.

Improvement of the ladder facilities will result in a strengthening and, presumably, an increased production of existing anadromous fish runs. This will provide an increased economic benefit to the local area through sport fishing and to the tribes and commercial fishing interests related to the Columbia system fishery* Benefits are discussed more fully in Chapter 9 of the Predesign Report.

MITIGATION

No critical impacts are anticipated and, therefore, no mitigation measures are presented at this time.

CHAPTER 16
ALTERNATIVES

The National Environmental Policy Act requires consideration of the "no action" alternative as well as reasonable modifications of the proposed action. Impacts of the proposed action are summarized in the following section with an analysis and comparison of the no action alternative. Further discussion of alternatives is also provided in the Predesign Report.

PROPOSED ACTION

The proposal is to renovate the left bank fish ladder at Tumwater Falls, and renovate the existing right bank ladder at Dryden as well as adding a left bank ladder. There are only minimal long-term impacts to vegetation, wildlife, hydrology, air quality, soils, cultural resources, noise and economics, and potential minor impacts to land use, fish, water quality and recreation. Aesthetic impart will be mitigated by project design, construction methods and scheduling. As designed, it is not anticipated that the project will affect hydropower potential at either dam. There will be positive project benefits to fish, recreation and economics of the area through strengthening and improving the anadromous fish run.

NO ACTION

A No Action alternative would leave the fish ladders in their present condition. The ladders currently require high maintenance to function properly and are significantly decayed. The ladders cause various problems to the successful passage of anadromous fish which have been documented in the Predesign Report.

No action would leave the passage facilities in their present marginal condition. None of the minor impacts associated with the proposed action would occur, however, there would be no positive benefits. With continued decay and passage problems, no action may result in a net long-term decline in anadromous fish runs in the Wenatchee River.

RIGHT AND LEFT BANK FISHWAYS AT TUMWATER FALLS

This alternative involves the same proposed action at Dryden but the addition of a right bank fishway at Tumwater Falls. The difference from the proposed action involves equipment access across the river since no roadway access is available. This could involve impacts on water quality and fisheries, depending on the method used. This alternative could also interfere with future hydropower potential at Tumwater Falls and the "natural" designation of the Shoreline Master Plan. As noted in the Predesign Report, the right bank fishway at Tumwater Falls is neither necessary nor cost effective.

OTHER ALTERNATIVES

Other alternatives considered include the repair of the existing ladders at the sites and addition of a left bank ladder at Dryden Dam. This would provide impacts nearly identical to the proposed action, since construction would occur in the same areas. However, this alternative cannot be viewed as a long-term solution to fish passage difficulties at both dams. The principal difficulties at passage facilities would still remain and complete rehabilitation, as proposed, would only be delayed. In view of the valuable Wenatchee River anadromous fish resource, the only reasonable action is complete rehabilitation as proposed.

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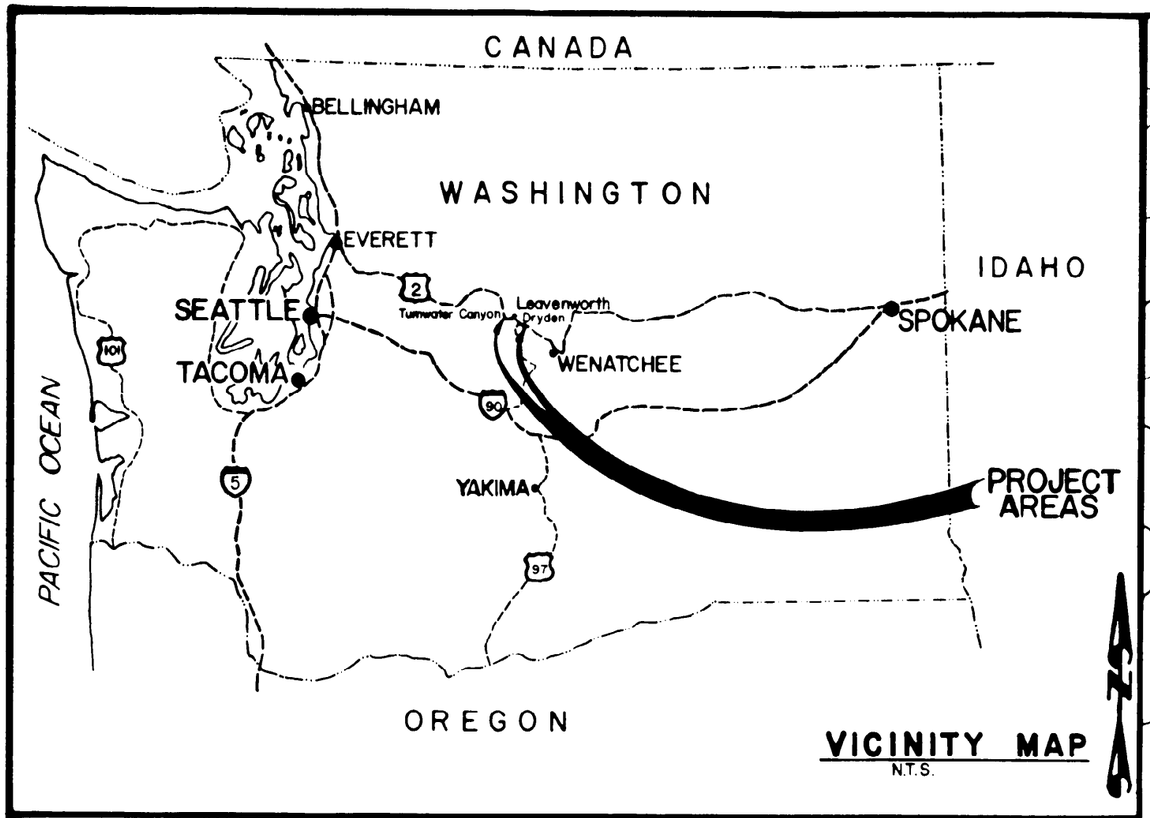
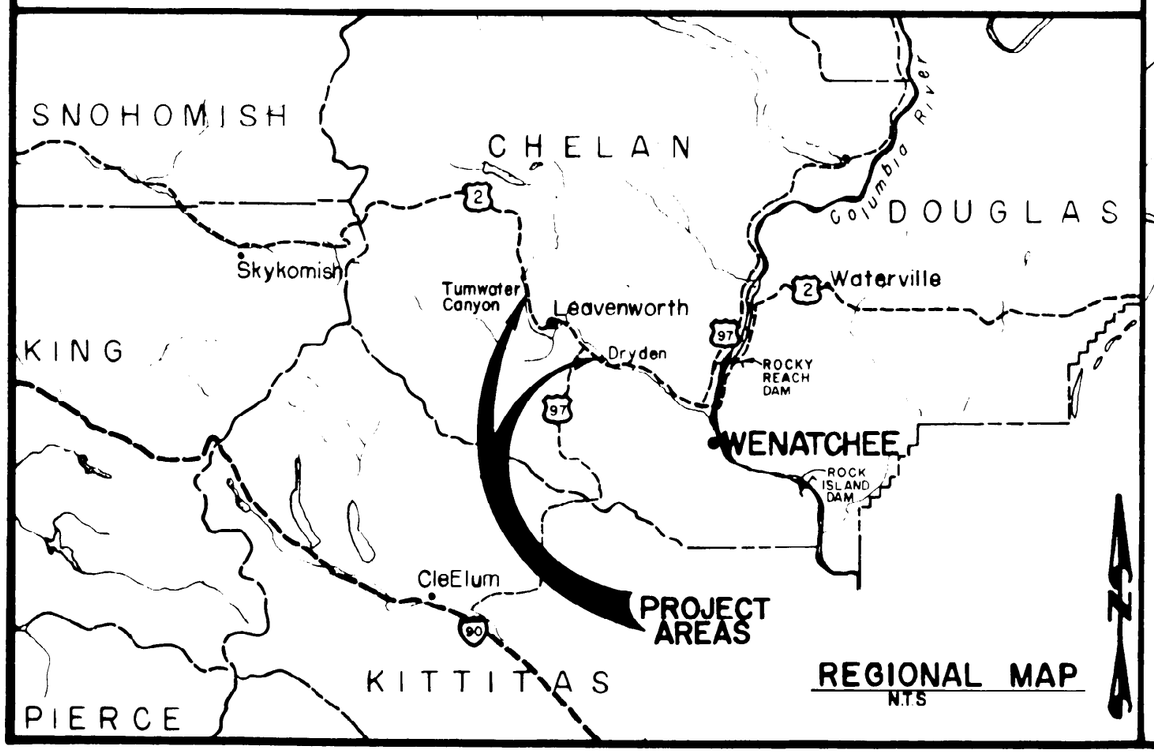
APPENDIX A

FIGURES





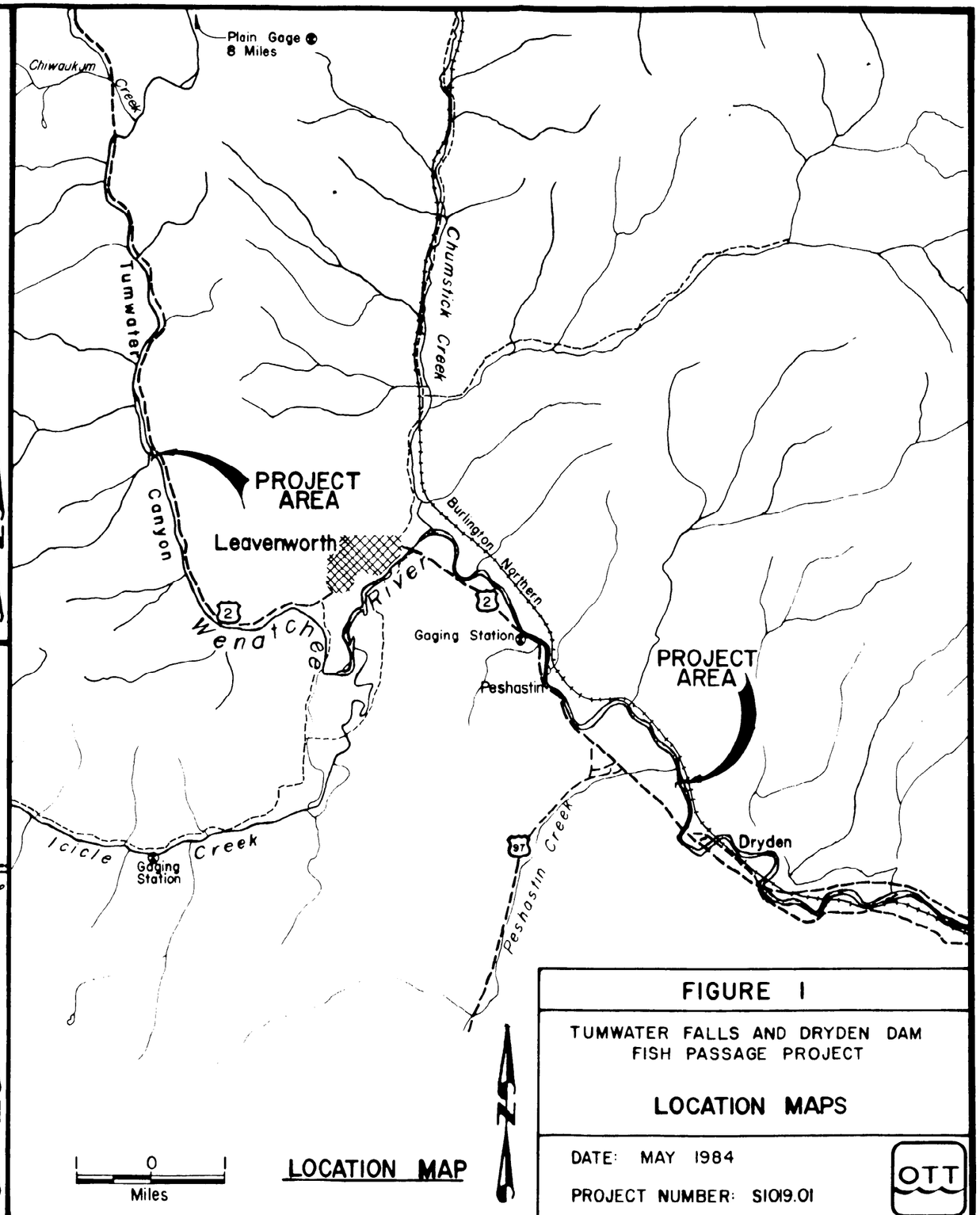


FIGURE 1

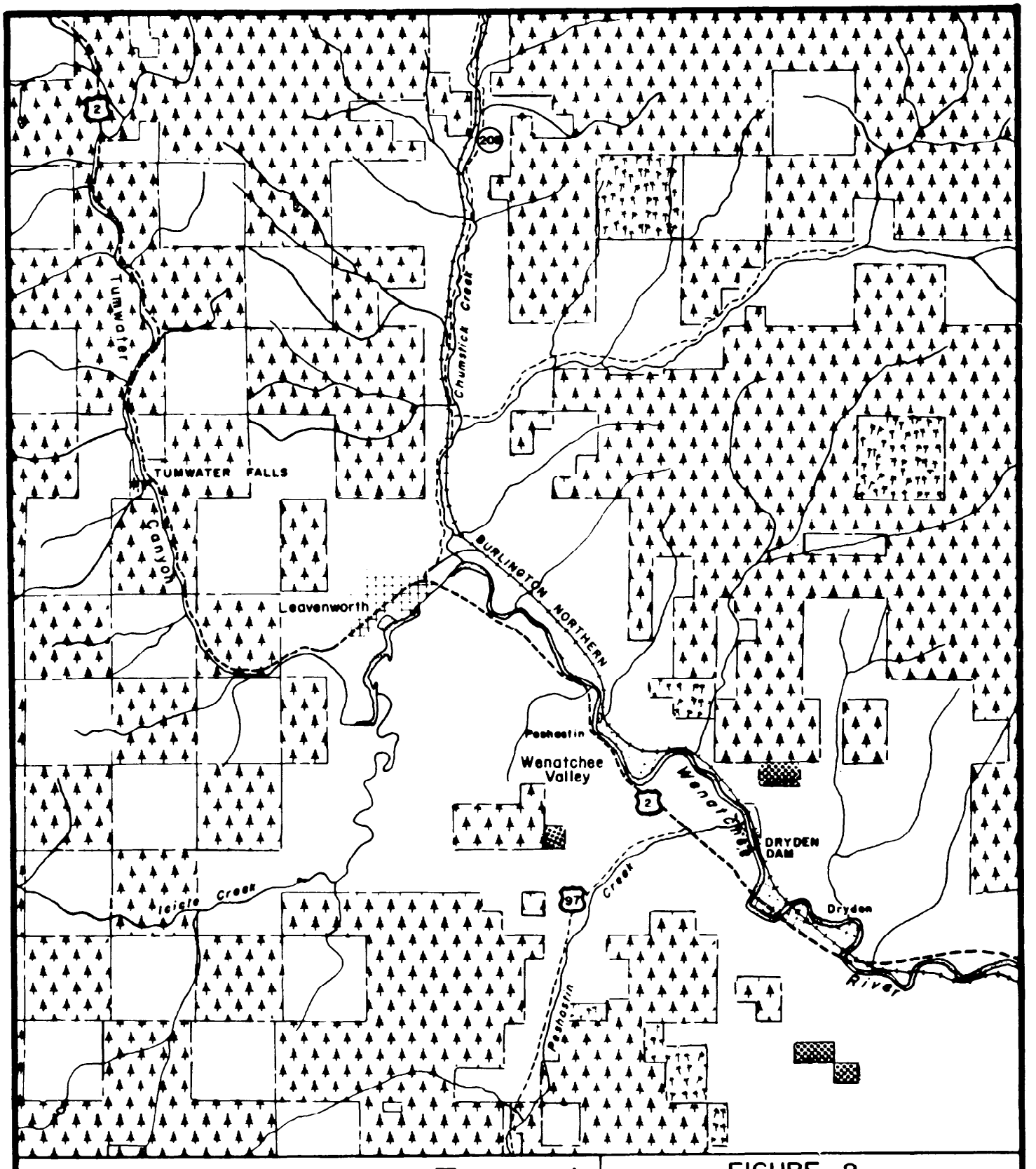
TUMWATER FALLS AND DRYDEN DAM
FISH PASSAGE PROJECT

LOCATION MAPS

DATE: MAY 1984

PROJECT NUMBER: S1019.01

OTT



Wenatchee National Forest
BLM Lands
Washington State Dept. of Natural Resources
Other Lands
Developed Lands

1 1/2 0 1 2 Miles

N

FIGURE 2

TUMWATER FALLS AND DRYDEN DAM
FISH PASSAGE PROJECT

LAND USE MAP

DATE: MAY 1984
JOB NUMBER: S1019.01

OTT

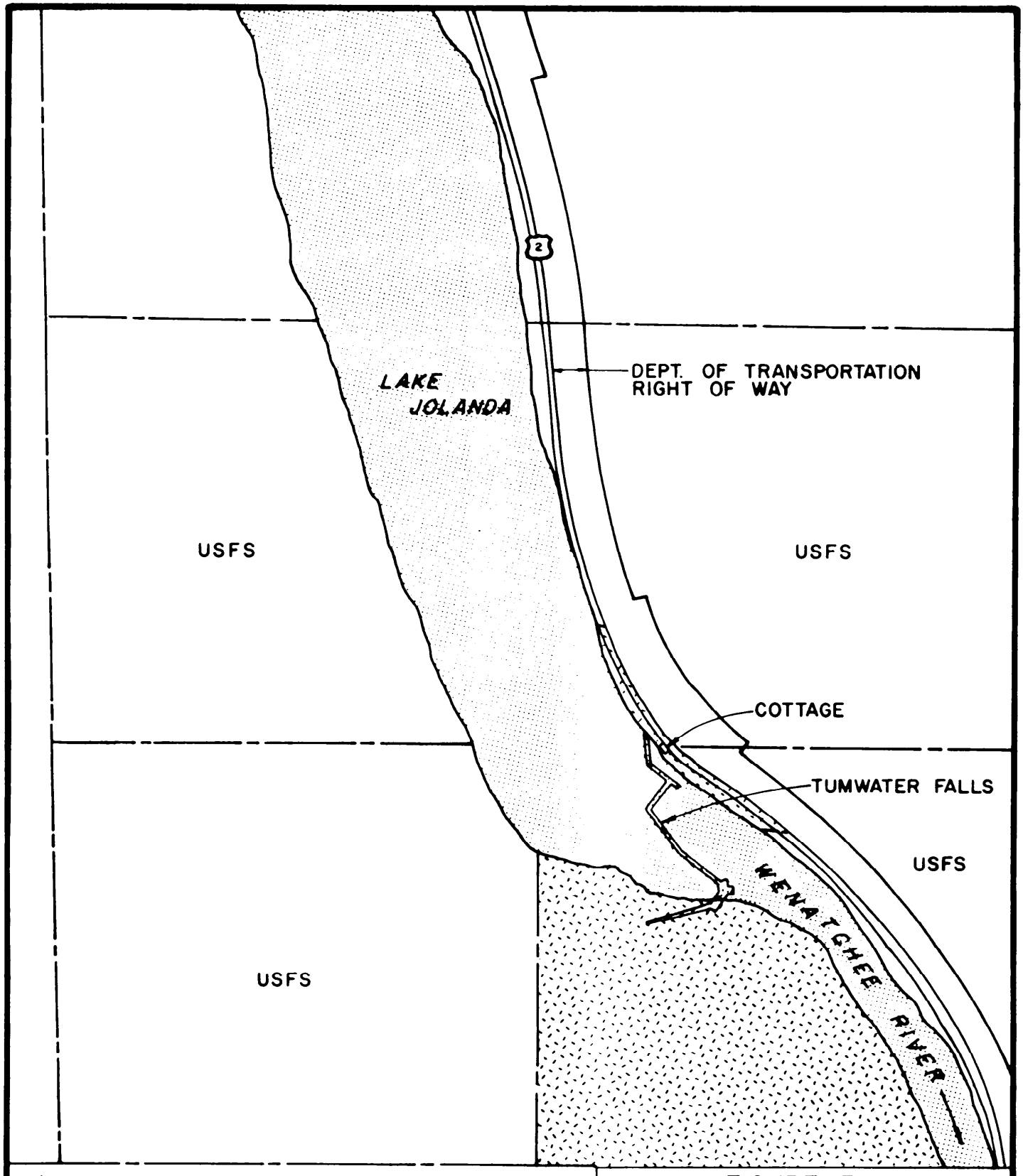


FIGURE 3

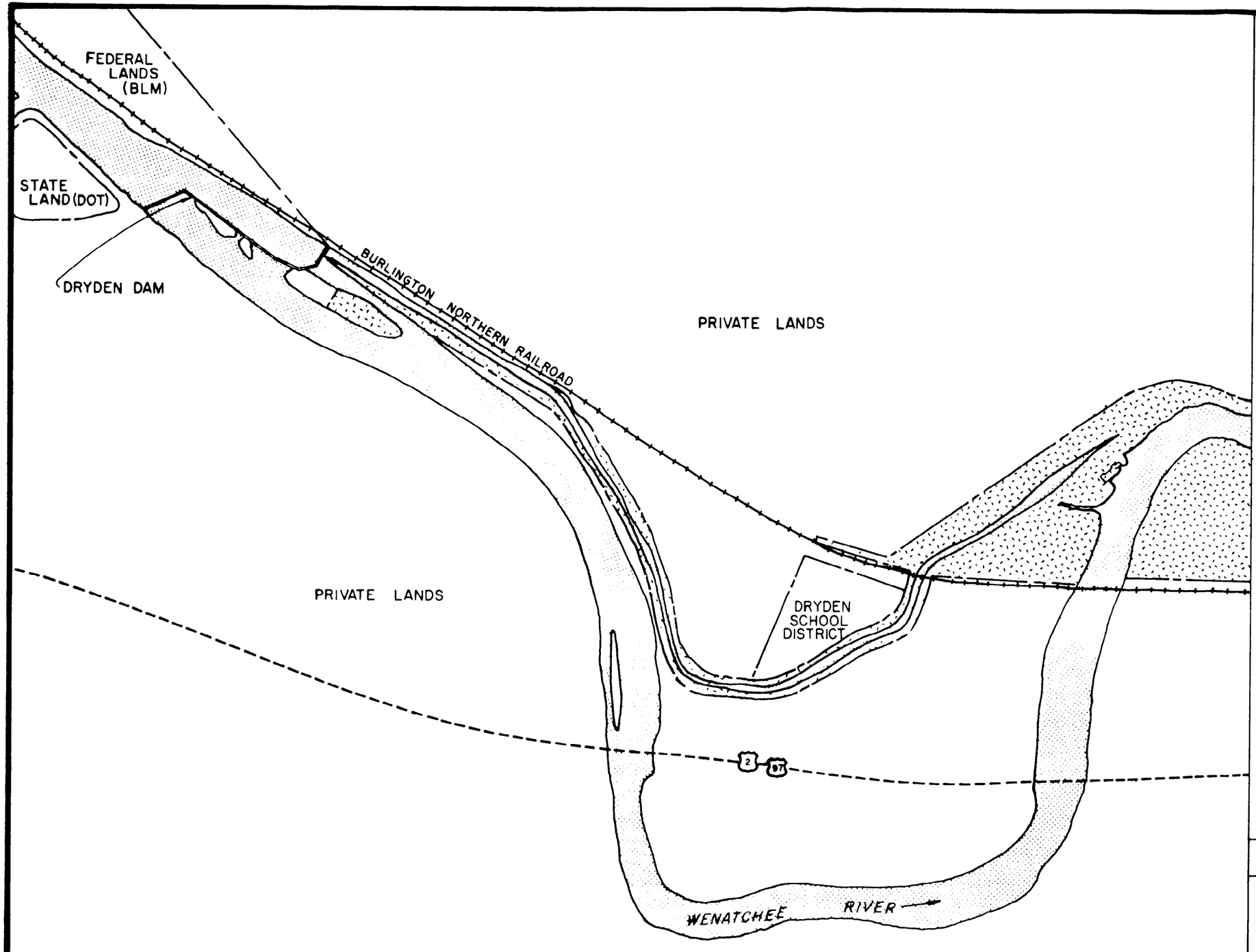
TUMWATER FALLS AND DRYDEN DAM
FISH PASSAGE PROJECT

TUMWATER FALLS
LAND OWNERSHIP MAP

DATE: MAY 1984

JOB NUMBER: S1019.01

OTT



LAND OWNERSHIP BOUNDARIES

CHELAN COUNTY PUD

SOURCE: CHELAN COUNTY PUD 1980

400 200 0 400 800 Feet

FIGURE 4

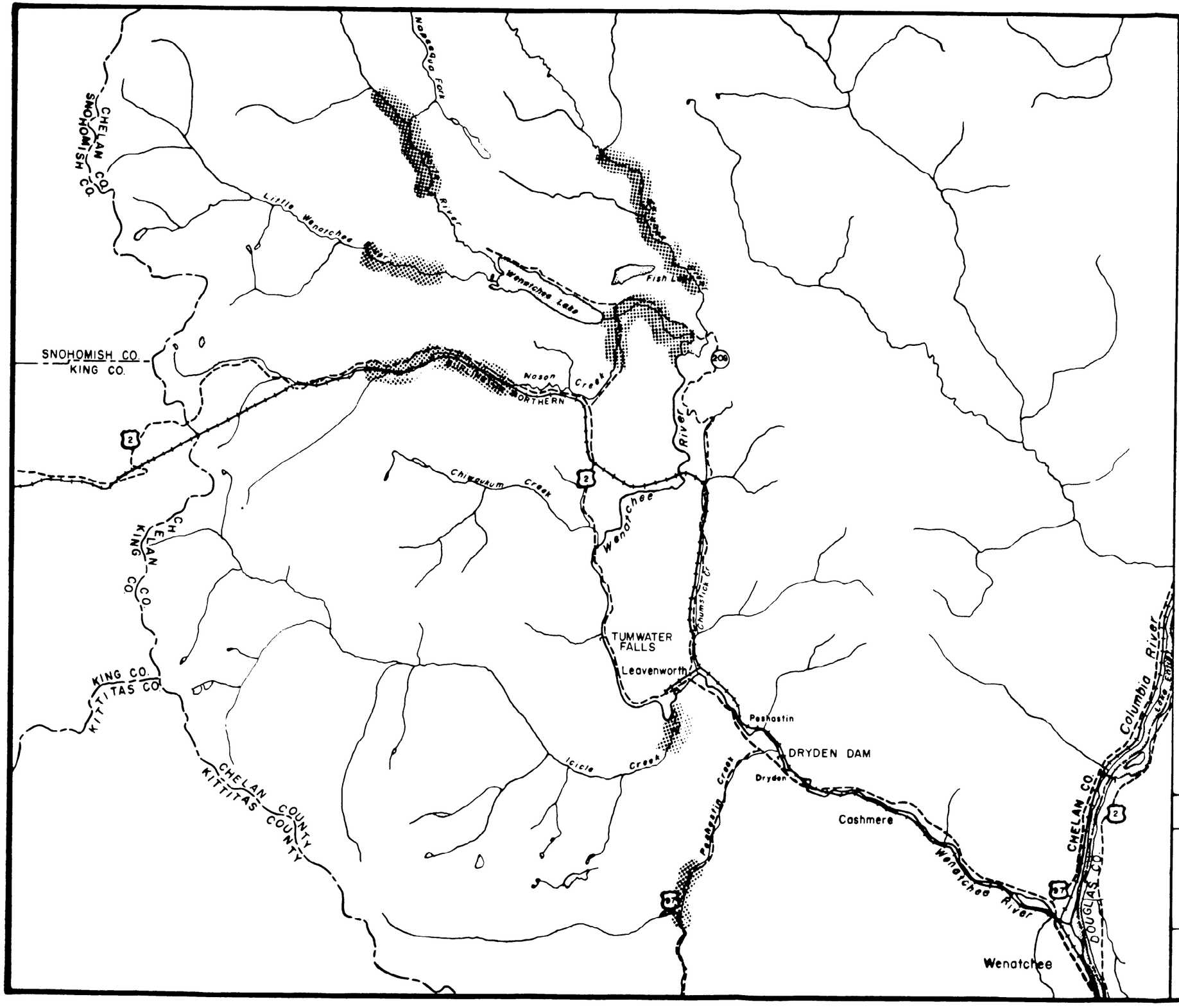
TUMWATER FALLS AND DRYDEN DAM
FISH PASSAGE PROJECT

DRYDEN DAM
LAND OWNERSHIP MAP

DATE: MAY 1984

PROJECT NUMBER: S1019.01

OTT



SPRING CHINOOK SPAWNING AREAS

SOURCE: WASHINGTON DEPARTMENT OF FISHERIES
WENATCHEE RIVER SALMON RESOURCE, NO DATE

CHELAN COUNTY PUD, PERSONAL COMMUNICATIONS, 1984.

5 0 5
Miles

FIGURE 5

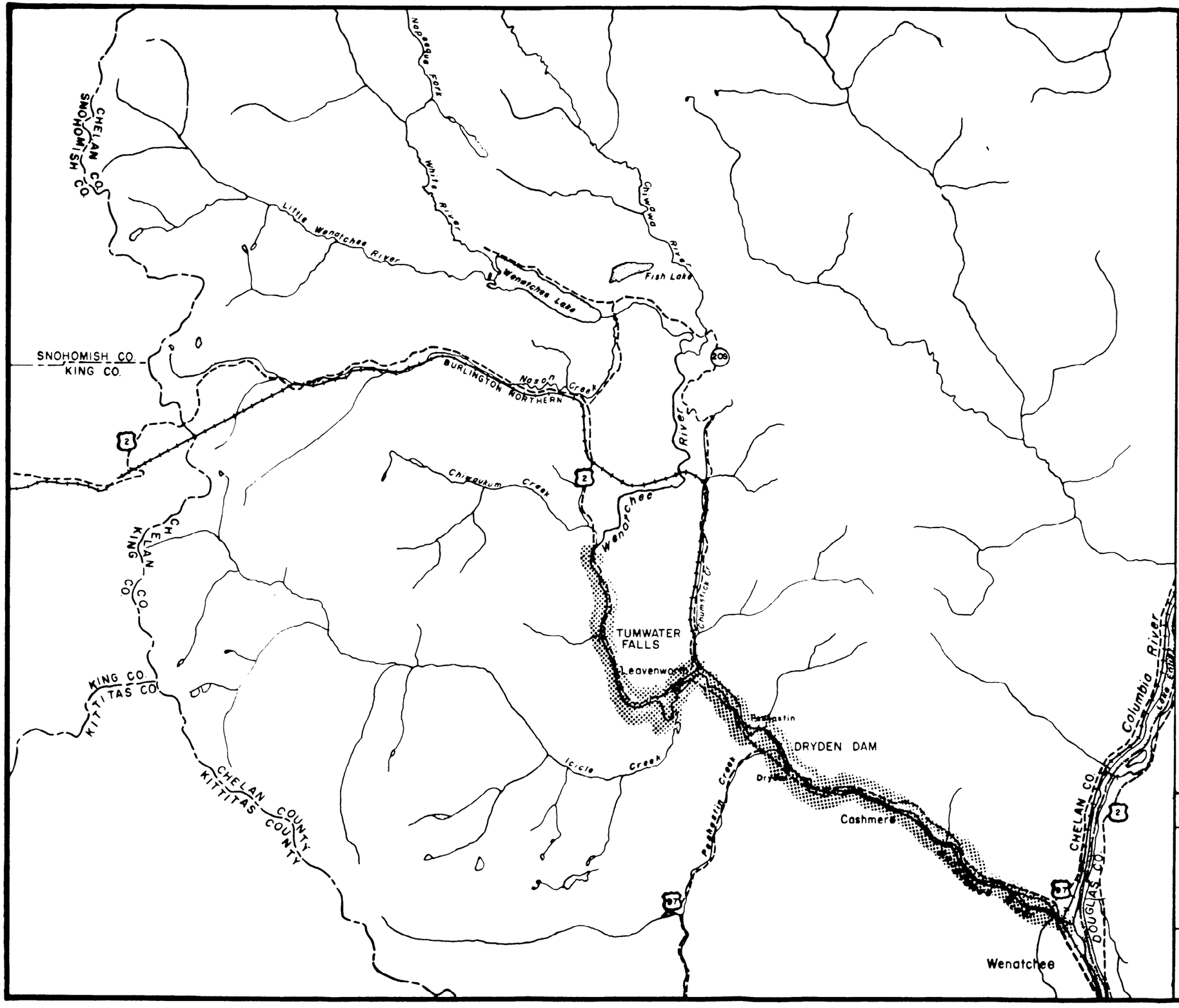
TUMWATER FALLS AND DRYDEN DAM FISH PASSAGE PROJECT

SPAWNING AREAS MAP

DATE: MAY 1984

PROJECT NUMBER: S1019.01

OTT



SUMMER CHINOOK SPAWNING AREAS

SOURCE: WASHINGTON DEPARTMENT OF FISHERIES
WENATCHEE RIVER SALMON RESOURCE, NO DATE

CHELAN COUNTY PUD
PERSONAL COMMUNICATIONS, 1984.

FIGURE 6

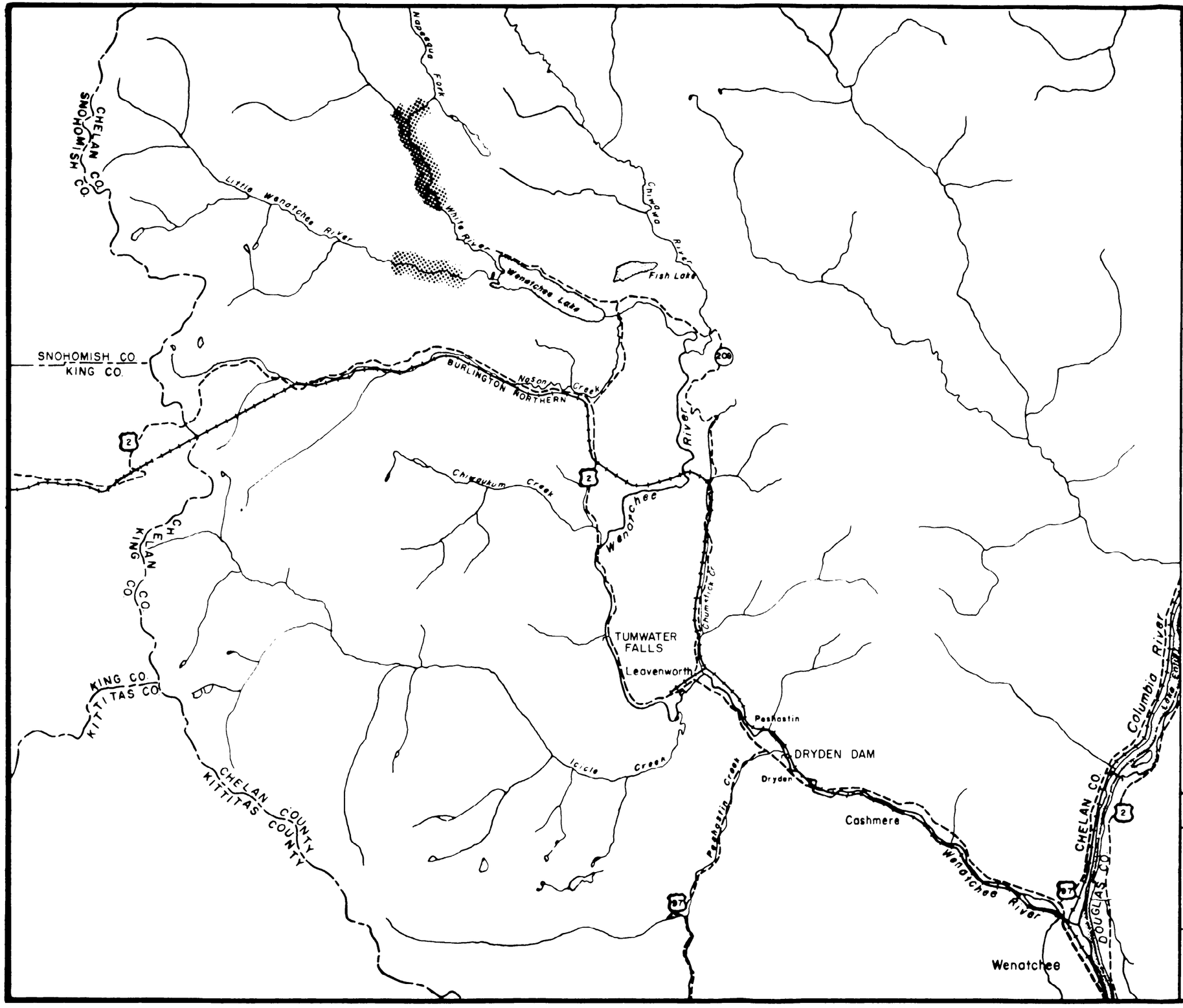
TUMWATER FALLS AND DRYDEN DAM
FISH PASSAGE PROJECT

SPAWNING AREAS MAP

DATE: MAY 1984

PROJECT NUMBER: S1019.01

OTT



SOCKEYE SALMON SPAWNING AREAS

SOURCE: ALLEN & MEEKER 1980
CHELAN COUNTY PUD, PERSONAL COMMUNICATIONS, 1984.

N

5 0 5
Miles

FIGURE 7

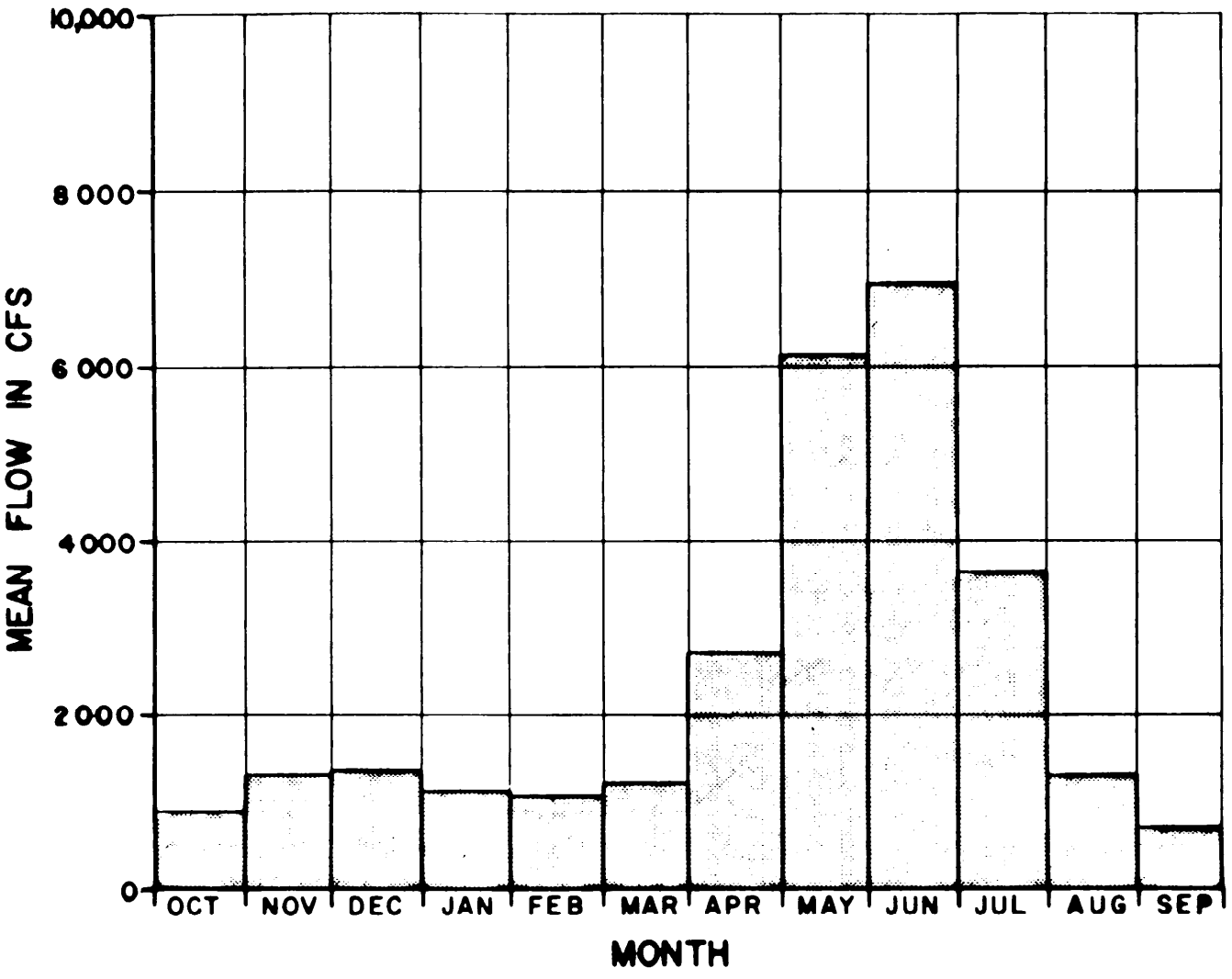
TUMWATER FALLS AND DRYDEN DAM FISH PASSAGE PROJECT

SPAWNING AREAS MAP

DATE: MAY 1984

PROJECT NUMBER: S1019.01

OTT



NOTE: PLAIN GAGE DATA FROM 1911 TO 1974, ADJUSTED TO TUMWATER FALLS

FIGURE 8

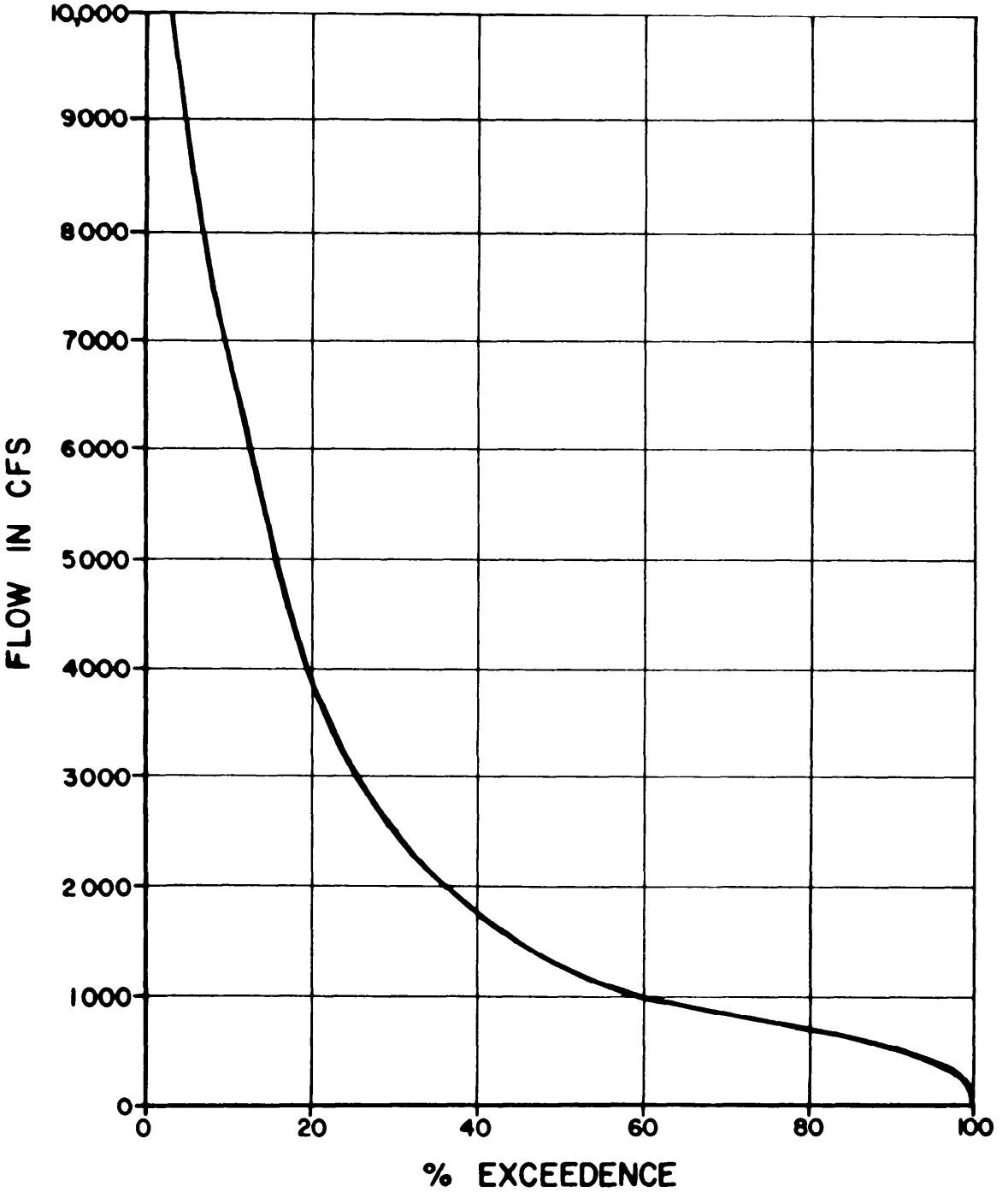
TUMWATER FALLS AND DRYDEN DAM FISH PASSAGE PROJECT

TUMWATER FALLS MEAN MONTHLY HYDROGRAPH

DATE: MAY 1984

JOB NUMBER: S1019.01

OTT



NOTE: PLAIN GAGE DATA FROM 1911 TO 1974, ADJUSTED TO TUMWATER FALLS

FIGURE 9

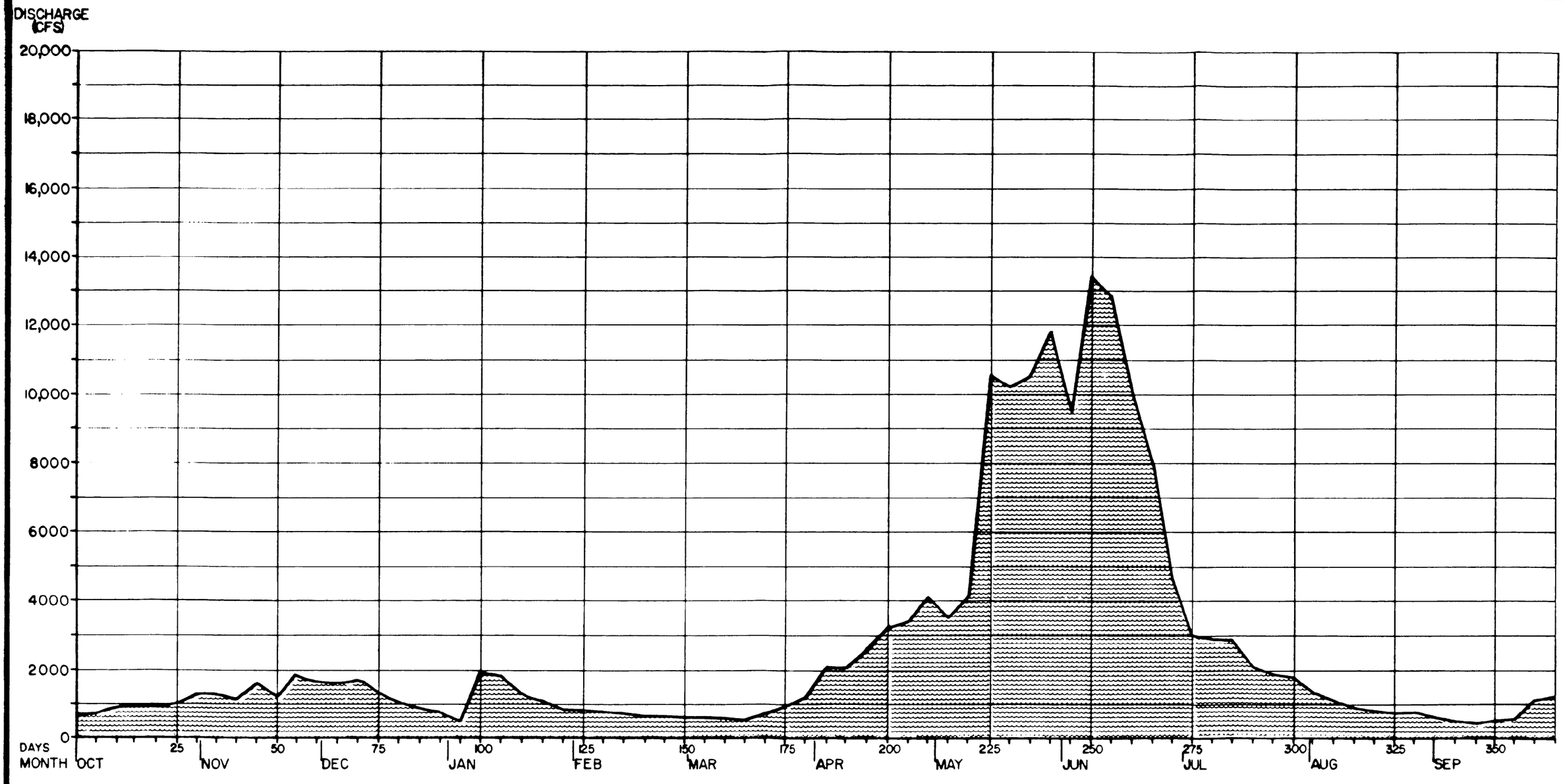
TUMWATER FALLS AND DRYDEN DAM FISH PASSAGE PROJECT

TUMWATER FALLS FLOW DURATION CURVE

DATE: MAY 1984

JOB NUMBER: S1019.01

OTT



NOTE: WATER YEAR 1969, PLAIN GAGE DATA ADJUSTED TO TUMWATER FALLS

FIGURE 10

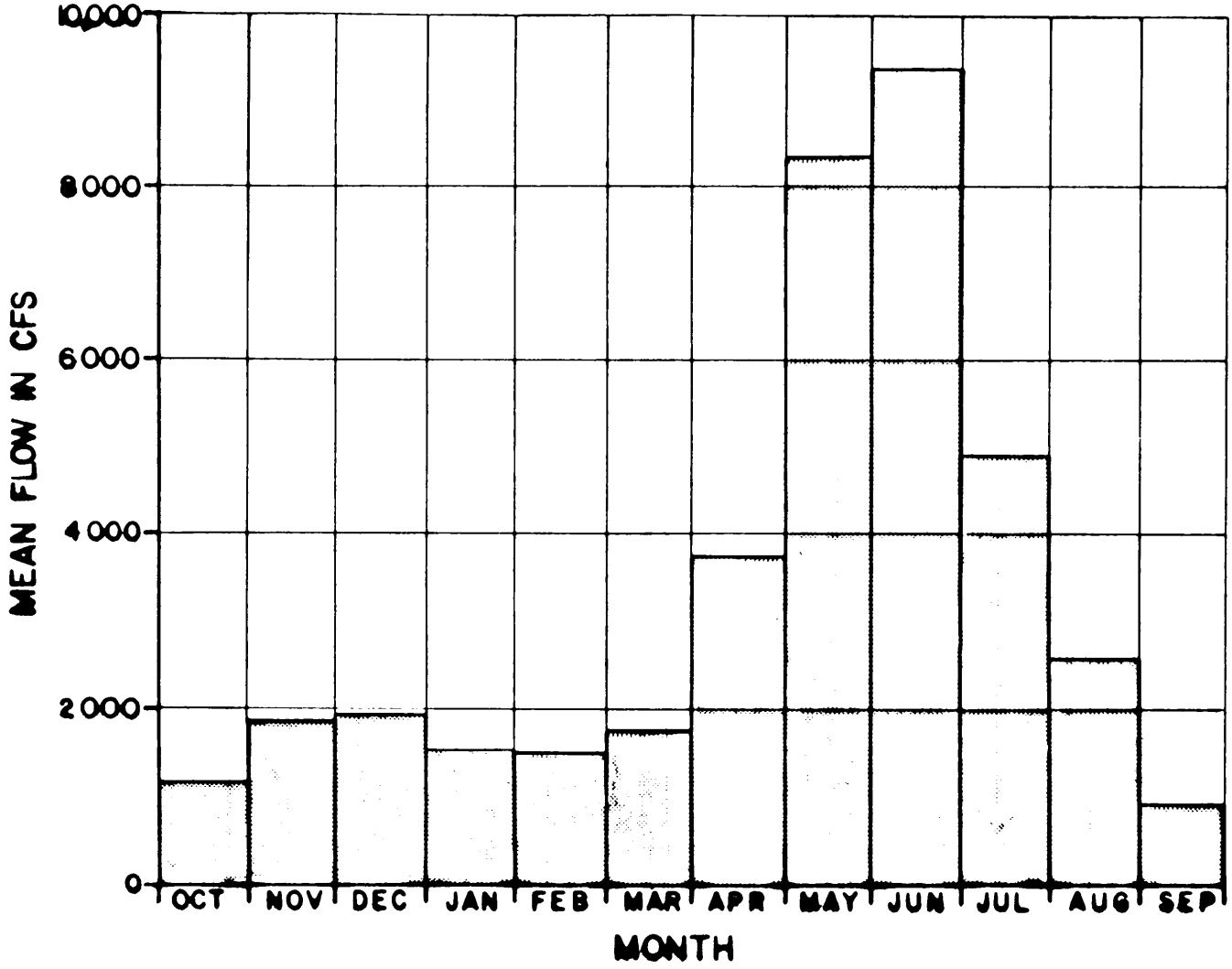
TUMWATER FALLS AND DRYDEN DAM FISH PASSAGE PROJECT

TYPICAL WATER YEAR AT TUMWATER FALLS

DATE: MAY 1984

PROJECT NUMBER: S1019.01

OTT



NOTE: PESHASTIN GAGE DATA FROM 1930 TO 1981, ADJUSTED TO DRYDEN DAM

FIGURE 11

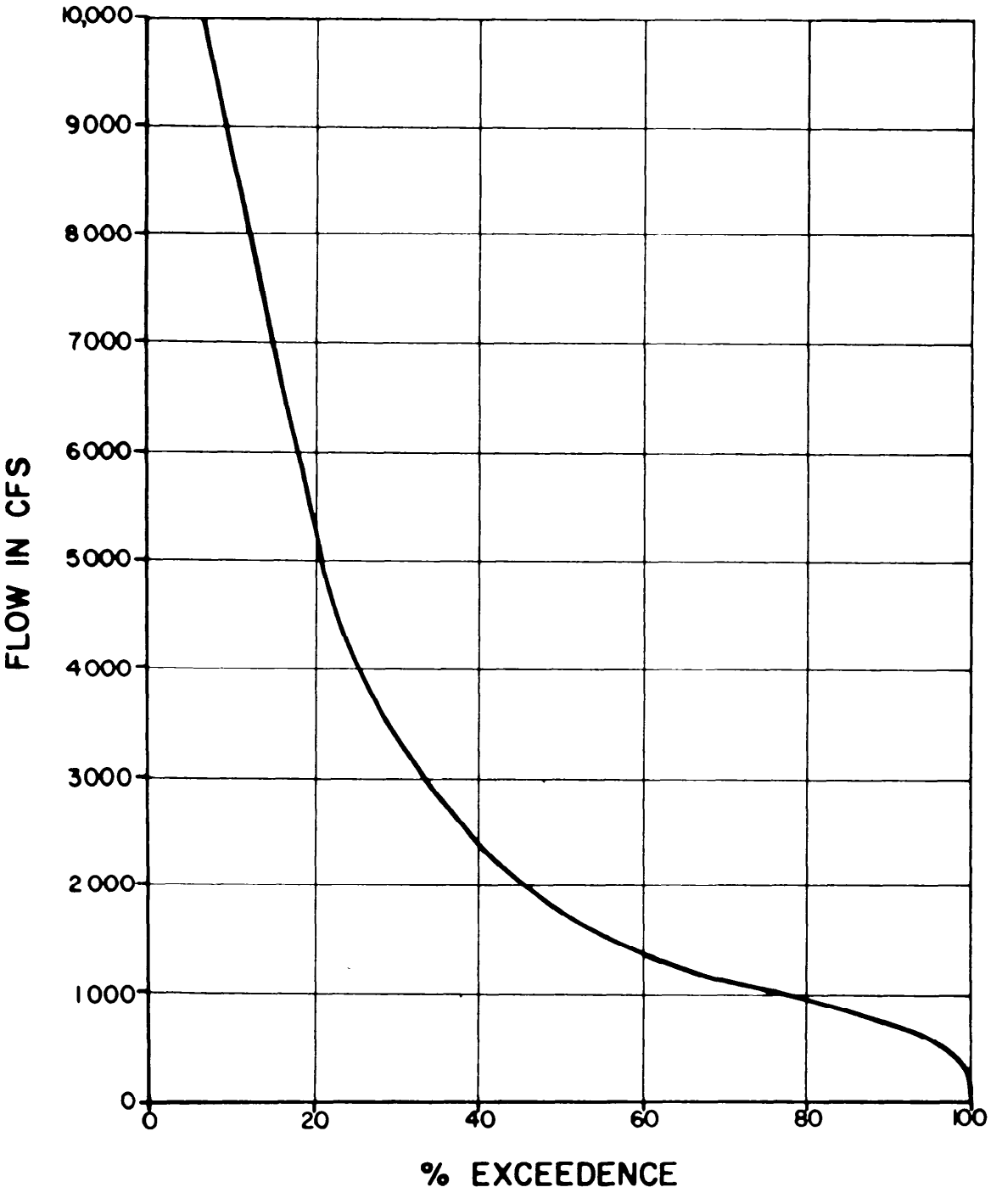
TUMWATER FALLS AND DRYDEN DAM
FISH PASSAGE PROJECT

DRYDEN DAM
MEAN MONTHLY HYDROGRAPH

DATE: MAY 1984

JOB NUMBER: S1019.01

OTT



NOTE: PESHASTIN GAGE DATA FROM 1930 TO 1981, ADJUSTED TO DRYDEN DAM

FIGURE 12

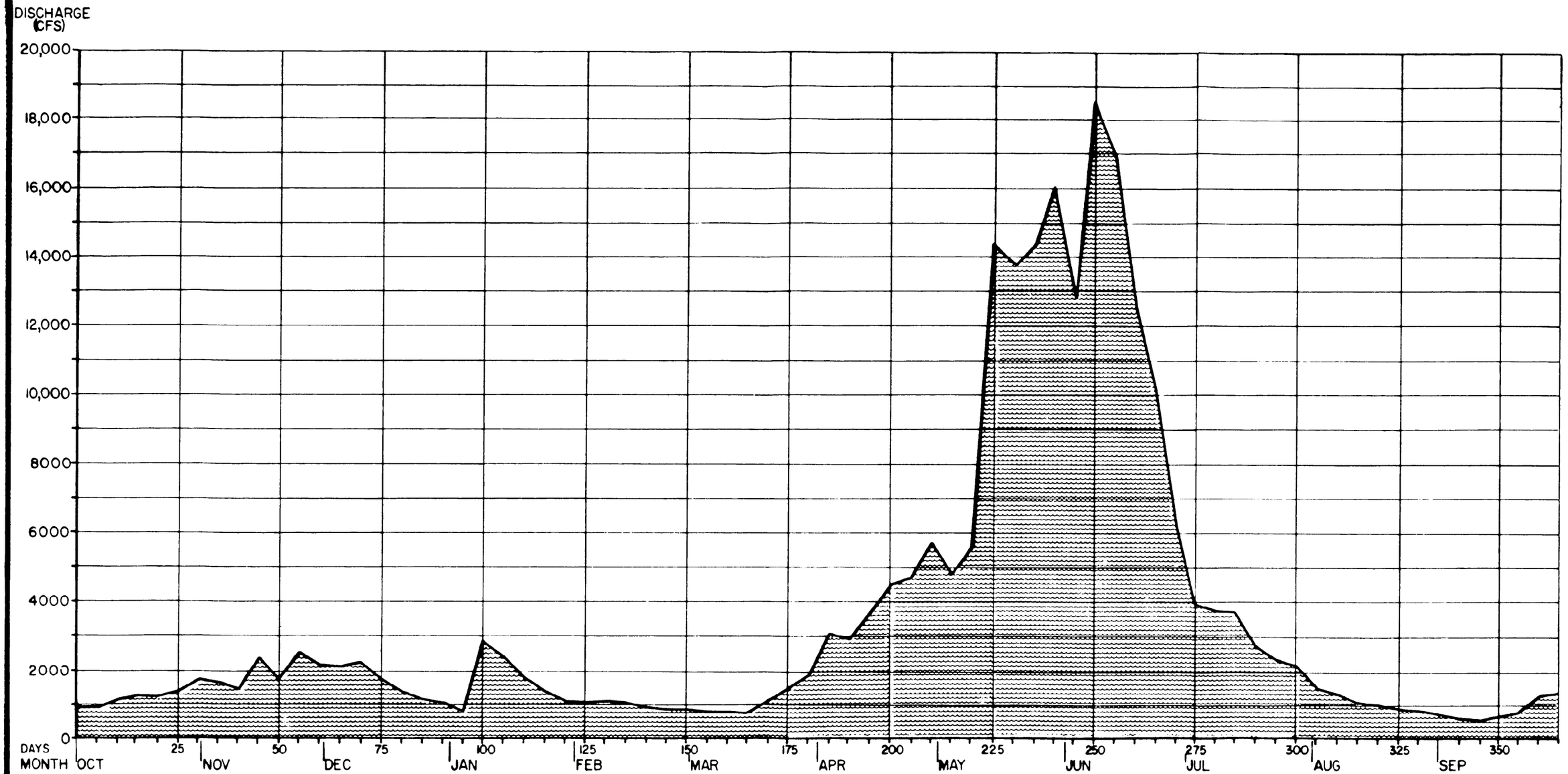
TUMWATER FALLS AND DRYDEN DAM
FISH PASSAGE PROJECT

DRYDEN DAM
FLOW DURATION CURVE

DATE: MAY 1984

JOB NUMBER: S1019.01

OTT



NOTE: WATER YEAR 1969, PESHASTIN GAGE DATA ADJUSTED TO DRYDEN DAM

FIGURE 13

TUMWATER FALLS AND DRYDEN DAM
FISH PASSAGE PROJECT

TYPICAL WATER YEAR
AT DRYDEN

DATE: MAY 1984

PROJECT NUMBER: S1019.01

OTT

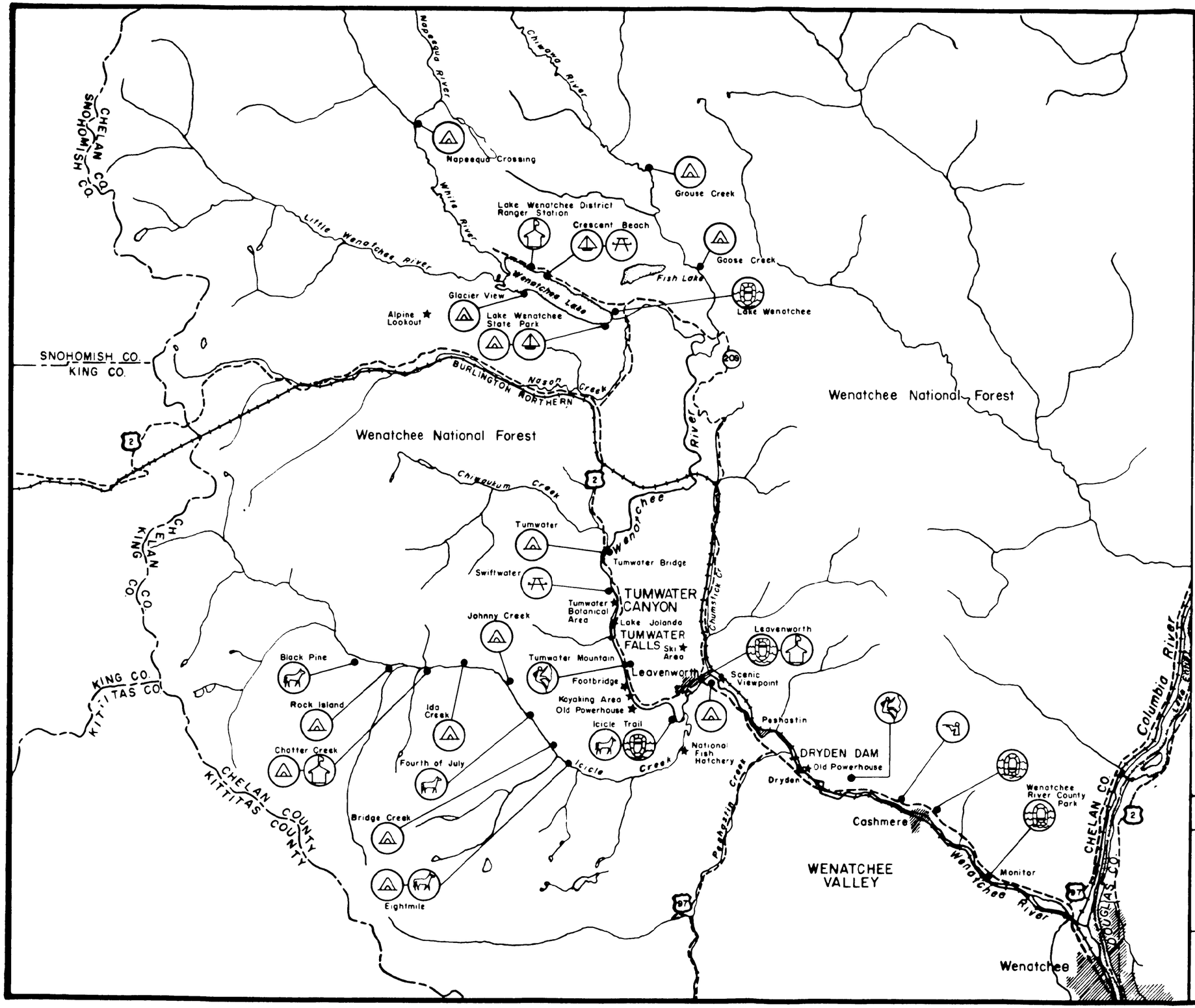


FIGURE 14

TUMWATER FALLS AND DRYDEN DAM FISH PASSAGE PROJECT

RECREATIONAL LAND USE MAP

DATE: MAY 1984

PROJECT NUMBER: S1019.01

OTT

FINAL REPORT

REGULATORY PERMITS

TUMWATER FALLS AND DRYDEN DAM
FISH PASSAGE PROJECT

MAY 1984

TABLE OF CONTENTS

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LIST OF TABLES

CHAPTER 1
INTRODUCTION

GENERAL

As part of Ott Mater Engineers', Inc. (OTT) efforts on the Tumwater Falls and Dryden Dam Fish Passage Project, Bonneville Power Administration (BPA) requested that the necessary regulatory permits for construction and operation of new fish passage facilities be defined and documented. This report has been prepared in response to BPA's request.

SCOPE OF PROJECT

Tumwater Falls and Dryden Dam are located on the Wenatchee River in Central Washington. Both dams were built in the early 1900's. Fish passage facilities were included in the initial construction, and were renovated in the 1940's. Over time, the passage facilities have deteriorated and present conditions are less than adequate to effectively pass adult anadromous fish. Further, the state-of-the-art in fishway design has progressed considerably and existing facilities could be substantially upgraded. This would undoubtedly result in a positive benefit to anadromous fish in the Wenatchee River system.

The scope of OTT's contract with BPA includes engineering feasibility and predsign, environmental review, and scope of regulatory permits. The intent of this project is to clearly define the most effective alternative for fish passage improvement at each of the dams, while providing the environmental analysis of the proposed project impacts. Consequently, appropriate mitigation can be developed and necessary permits can be scheduled to expedite the design, construction and operation of the proposed facilities.

SCOPE OF REPORT

This report outlines the various regulatory permits prerequisite to the construction and operation of the proposed fishway facilities at Tumwater Falls and Dryden Dam. An overview of the required permits and the issuing agencies is presented with detailed descriptions of the required review times, terms of Issuance, information requirements and fees for each permit.

CHAPTER 2
PERMIT REQUIREMENTS

GERNEAL

Since Tumwater Falls and Dryden Dam are distinct sites, located approximately 13.3 river miles apart, separate permits must be secured for each project. To facilitate funding, BPA may elect to consider the proposed project as separate efforts. The division of the proposed project is expected to simplify the procurement and management of construction as well.

PERMITS NEEDED

Construction at either or both sites may begin as early as BPA's FY 1985. Prior to construction, permits must be obtained from the following agencies:

- Chelan County Planning and Building Departments
- Washington State Department of Fisheries (WDF)
- Washington State Department of Ecology (DOE)
- Washington State Department of Transportation (DOT)
- U.S. Army Corps of Engineers (USCE)

A special use permit may also be required from the U.S. Forest Service if their lands will be used during construction. In addition, temporary easements must be secured from landowners at the project sites. At Tumwater Falls the only affected landowner is Chelan County PUD although other federal and private lands are nearby. Landowners at the Dryden site include Chelan County PUD, the State of Washington and Burlington Northern Railroad.

The following is a list of the specific permits that must be secured:

- Shoreline Permit (Chelan County)
- Building Permit (Chelan County)
- Hydraulic Project Improvement Permit (WDF)
- Dam Safety Permit (DOE)
- Water Quality Variance Permit (DOE)
- Water Rights Permit (DOE)
- Section 404 Permit (USCE)
- General Use Permit (DOT)

Each of these permits requires that the applicant provide specific information pertaining to the design and environmental resources as well as other considerations.

APPLICATION REQUIREMENTS

Generally, when construction activities are proposed in or on the shoreline of a stream, resource agencies request considerable detail about the design, scheduling and environmental effects of the proposed work. Therefore, substantial engineering and predesign must be accomplished before the permitting process can begin.

Because regulatory agencies are responsible for the management of a wide variety of environmental resources, each agency sets specific conditions for approval and defines information required of the applicant. For example, a completed Hydraulic Project Improvement Permit application submitted to WDF consists of a completed form accompanied by an Environmental Assessment and additional details concerning construction methods and scheduling in relation to anadromous fish migration. Similarly, the USCE requires general design drawings along with specific construction and environmental review information for a Section 404 Permit (for dredging and excavation activities). Some agency

authorizations listed above include the completion of a prepared form, while others are obtained by submitting for review a letter of application with pertinent information about the project. Construction design or predesign drawings are required to secure the Shoreline, Building and Dam Safety permits. An Environmental Assessment report is needed to obtain Shoreline and Hydraulic Project Improvement Permits.

SCHEDULING

In addition to specific information and format requirements, each agency establishes different review periods for their permits. These factors, combined with the fact that some permits require prior approval of other cooperating agencies, indicate the importance of timing and scheduling the permit process.

Consider as an example, the construction of a building along a river bank. A Shoreline Permit takes a maximum of 90 days to be reviewed by the Chelan County Planning Department and mandates that construction must be completed within one year from the date of issuance (six years maximum if extensions are issued). The Building Department can authorize a Building Permit in seven days, but an approved Shoreline Permit is prerequisite for securing a Building Permit. Also, the Department states that work must begin within six months of the issuance date. Similarly, a Water Quality Variance Permit is issued at the same time or after the Hydraulic Project Improvement Permit (by the DOE and WDF, respectively), since the conditions set forth for construction scheduling and activities are the same for both agencies.

Clearly, a schedule must be established for submitting and receiving the necessary permits for the fish ladder renovations at Tumwater Falls and Dryden Dam. Since some agencies do not have established rules for application review, care should be taken in scheduling the permit process. Allowances should also

be made for requests for additional information by resource agencies. It should be noted that the application process should not begin until adequate engineering and planning has been completed. A sequence diagram for permitting is presented in Figure 1, This diagram can be used to generate a final schedule when design information is more complete. A permitting summary is also given in Table 1.

CHELAN COUNTY

SHORELINE PERMIT

A Shoreline Permit from the Planning Department of Chelan County is necessary for construction projects located along a natural waterway. Only facility repairs or minor structural modifications are exempt from this requirement.

The materials required for a Shoreline Permit are an application form for projects of substantial development, maps, design drawings, and a SEPA Environmental Checklist. Specific information must be furnished on the maps and drawings, an enumeration of which is given on the application instructions. In addition, descriptions of design and construction materials such as volume and composition of fill are required.

The Environmental Checklist is an eight-page form indicating changes or potential impacts on the environment and nearby human population. This is a standard form used by all state and local agencies in Washington. Most of the responses on the checklist are limited to "yes", "no" or "may be". Several questions require further explanation; corresponding responses can be appended to the form. Where necessary, the Environmental Review, included as part of this document, can be submitted as a supplement to the permit application.

Table 1.--Regulatory Permits Required for Construction and Operation of Tumwater Falls and Dryden Dam Fish Passage Facilities

Agency	Type of Authorization	Contact	Form	Review Period	Term	Fee	Application Material
Chelan County Planning Dept. Leavenworth, WA	Shoreline Permit	Jerry Litt	Yes	90 days	1 - 6 years	$150	Drawings, description of activities, completed application, and Environmental Assessment
Chelan County Building Dept. Leavenworth, WA	Building Permit	Mike Brennan	Yes	30-45 days	1/2 1 year	Based on project value	Approved Shoreline Permit, design drawings and completed application
Washington Dept. of Fisheries Olympia, WA	Hydraulic Project Improvement Permit	Mylard Deausem	Yes	45 days	1 - 5 years	None	Completed application and Environmental Assessment
Washington Dept. of Ecology Olympia, WA	Dam Safety Permit	Ed Garling	No	N/A	N/A	$10	Complete plans, specifications and existing dam as-built drawings
Washington Dept. of Ecology Yakima, WA	Water Quality Variance Permit	John Hodgson	No	30 days	1 - 5 years	None	Letter application, project explanation and drawings
Washington Dept. of Ecology Yakima, WA	Water Rights Permit	Doug Clausing	Yes	180 days	Perpetual	$2/cfs	Completed application, maps and drawings
U.S. Army Corps of Engineers Seattle, WA	Section 404	Jack Kennedy	Yes	90 days	Duration of construction	$10	Completed application and drawings
U.S. Forest Service Leavenworth, WA	Special Use Permit	Steve Morton	No	14 days	Duration of construction	None	Letter application and description of work
Washington Dept. of Transportation Wenatchee, WA	General Use Permit	Luther Beaty	No	30 days	Duration of construction	None	Letter application and description of work

Due to the nature of the Tumwater Falls and Dryden Dam fishway projects, it is not likely that a comprehensive Environmental Impact Statement will be required. Chelan County's major concerns are likely to focus on construction methods such as the disposal of excavated material and type of fill used in cofferdams, and scheduling.

Approximately 90 days will be needed by the Planning Department to review the application materials, at a fee of $150 per application. Construction of the proposed project must be completed within one year after the permit has been issued. This can be extended up to a total of six years if a reasonable request is made by the applicant. No limitations are given regarding the beginning of construction, only the time for completion.

BUILDING PERMIT

Chelan County requires that a Building Permit be obtained from the Building Department in order to build or remodel a structure. Because the modifications to the Tumwater Falls and Dryden Dam fish ladders are substantial, the project is considered to be new construction.

As previously mentioned, a Shoreline Permit must be granted from the County before a Building Permit can be issued. The issuance of a Shoreline Permit from the Planning Department indicates that the proposed project has passed the environmental requirements of the County, and that the project designs need only be reviewed by the Building Department for safety and completeness.

Along with the completed Building Permit application form, design drawings must be included. Approximately 4-6 weeks are necessary to review the application materials and issue the permit, providing complete information is furnished about the proposed work and the Shoreline Permit has been approved.

The fee, which is due upon receipt of the permit application, is based on the total value of the project. An $800,000 project, the approximate construction cost of each fishway, would result in a Building Permit fee of approximately $2,200. At the discretion of the Department's director, the permit fee may be based on construction cost rather than on total value; this depends on the role that the County assumes regarding maintenance and inspection work.

After the Building Permit has been issued, construction must begin within six months. As defined by the County any "on-site work" that is associated with the project is defined as "construction". An additional six-month extension can be granted upon request of the applicant. For most projects, after the time limit has passed, a new application must be submitted and the review process repeated. However, for projects of considerable size and cost, the Building Department will be flexible in granting extensions. There are no time limits on construction completion for this permit. The completion date is controlled by the Shoreline Permit.

WASHINGTON DEPARTMENT OF FISHERIES

HYDRAULIC PROJECT IMPROVEMENT PERMIT

Washington State law requires that construction of any hydraulic project or work performed that will use, divert or obstruct any waters of the State, within ordinary high water lines, must be approved by the Department of Fisheries. A Hydraulic Project Improvement Permit must, therefore, be secured for construction of the Tumwater Falls and Dryden Dam fishways.

Generally, the project initiator is required to obtain the Hydraulic Project Improvement Permit. Approval of this permit is

prerequisite for a Water Quality Variance from the Department of Ecology and also hastens the processing of other agency certifications such as the Shoreline Permit. The Chelan County Planning Department and WDF are likely to serve as joint-lead agencies in the hydraulic approval and related environmental review of the project.

To obtain the permit, an application form must be completed and submitted to WDF, along with a SEPA Checklist and as much additional information as possible about the project. An Environmental Assessment nay also be required with the application. The Environmental Review portion of this document provides the basic information required for an Environmental Assessment.

Particular attention should be paid to construction scheduling which affects anadromous fish migration. The WDF is most interested in the construction timing as well as the methods and materials to be used. Presently, plans call for construction at both projects to take place during the late fall and winter month after most upstream fish runs have taken place.

The Hydraulic Project Improvement Permit is a construction term permit and has a limited useful duration. Approval usually lasts for one year, but can be extended to a maximum of five years if the construction schedule dictates that more time is needed. The time limits are specified by the Department of Fisheries depending on the project size, type and the potential environmental impacts during construction. The WDF allows 45 days to review the application, but exceptions can be made if the applicant can present due cause to shorten the review.

WASHINGTON DEPARTMENT OF ECOLOGY

DAM SAFETY PERMIT

When an existing dam is modified or a new dam is constructed, the Department of Ecology requires the project be approved through issuance of a Dam Safety Permit. Since the fish ladders at Turnwater Falls and Dryden Dam are an integral part of the dams, the dam structures themselves could be affected by the projects. Thus, this permit is necessary to demonstrate to the State that the structural integrity of the dams will not be compromised.

A letter of application is sent to the Dam Safety Section of the DOE, along with complete construction plans and specifications which have been formally reviewed by a Washington Registered Professional Engineer. Also required is information about the existing dam and how new facilities will tie into it. There is no specified review period for a Dam Safety Permit application, though four to six weeks is usually adequate. Submitting designs and descriptions in advance of the application is also advisable. A fee of $10 is charged for processing.

WATER QUALITY VARIANCE

The DOE requires that a Water Quality Variance Permit be secured if a project may disturb the quality of public waters. Although the constrtuction schedule and plans will be designed to minimize disruption of the Wenatchee River environment, some temporary disturbances of water quality may occur during construction.

A letter of application is submitted to the Department of Ecology along with pertinent information describing the project in general, methods and materials to be used during construction,

and schedules. Particularly important are activities which will require modification of the Water Quality Standards. The letter should specify:

- Time and duration of the proposed activity
- Standards to be modified
- Beneficial uses that will be affected
- Type and degree of treatment to be provided for any discharge

The letter should also address the requested duration of the permit and associated terms. In order to expedite the process, the Hydraulic Project Improvement Permit should be obtained in advance, so that a copy of this document can be enclosed with the Water Quality Variance application. The time required for review is variable, an3 depends on the project size and the potential project-related disturbances. Usually, a month is adequate for agency review, No fees are required.

WATER RIGHTS PERMIT

All surface water diversions or withdrawals require a Water Rights Permit from the DOE. The Tumwater Falls and Dryden dams Project represents an unusual situation in Water Rights permitting. Because the two dams and the associated ladders are currently functional and have never been assigned diversion rights, filing for new water permits would not be mandatory. However, preliminary designs indicate that extensive reconstruction wi11 take place and that the diverted flow will be increased considerably over existing amounts.

According to the Central Regional Office of the DOE in Yakima, Washington the only water rights applications at either dam have been related to power generation or irrigation diversion. Chelan

County PUD relinquished its original water rights in the 1950's after hydropower generation at the two project sites was terminated. The Wenatchee Reclamation District (WRD) possesses unqualified rights at Dryden Dam of 200 cfs for irrigation flow. The WRD has recently applied for an additional 50 cfs: the granting has been delayed because instream flow studies are being conducted by the Department of Fisheries.

Obtaining Water Rights Permits for the Tumwater Falls and Dryden dams fishways is advised since minimum Wenatchee River flows set to protect anadromous fish may not prevent future over-appropriation or changes in water management policies. Permits would provide documentation of the water distribution at the two dams and would protect the needs of anadromous fish. With the present claims for water at the sites, there should be no difficulties with applications. Preliminary designs call for a 180 cfs diversion through the Tumwater Falls fish ladder and 300 cfs at Dryden (150 cfs for each of the two ladders).

To obtain water rights permits an application form must be completed and submitted with supplemental maps and drawings. Space is provided on the form for mapping and describing the location of the diversion, however, the DOE encourages additional information. Three separate fees are paid to the DOE over the processing period for each application: an examination fee of $2/cfs submitted with the application; a filing fee of $20 (when fish propagation is the designated water use) or twice the examination fee, whichever is more; and recording fees of $5 each paid to the DOE and the Chelan County Auditor. Using the proposed design flows, the examination fees for Tumwater Falls and Dryden Dams would be $360 and $600, and the filing fees would be $720 and $1,200, respectively. There are no annual fees for water rights certification.

At least six months will be needed by the DOE to review the applications and issue a report of findings and conclusions. This period includes a mandatory 30-day public comment period, during which the applicant issues a Notice of Intent in a local newspaper. If the DOE report approves the issuance of a water right and the applicant agrees with the terms, a permit is issued. The permit serves as an approval for construction, hence the project is subject to review by the DOE until the project completion and the appropriated water has been put to use. Thereafter, the construction permit becomes a perpetual certificate.

The construction time limits are one year to start, one year to complete the project, and one year to put the appropriated water to use. These rules are negotiable, however, depending on the needs of the applicant. The applicant's work schedule is usually incorporated into the permit, and lead times longer than one year can be approved if valid reasons are stated.

The name of the water rights applicant is most significant during the permit/construction phase, since liability must be assigned during construction. Once the project is complete, the certificate is considered to be attached to the land or structure to which it applies rather than the right of the applicant.

Although these fish passage projects are funded by the Bonneville Power Administration, Chelan County PUD owns the sites and will continue to do so in the future. Chelan County PUD is also charged with maintaining the fishways. Owing to the legal aspects of the water right certificate, an awkward situation could be created by BPA applying for water rights that will become attached to property belonging to Chelan County PUD. Therefore, consideration should be given to name Chelan County PUD as obtaining the water rights application at Tumwater Falls and Dryden Dam rather than BPA. Alternatively, BPA could apply

on behalf of Chelan County PUD. Chelan County PUD has expressed willingness to assume the responsibility of holding the certificate. With either plan, the right to divert water through new fishways would be ensured.

The steps necessary to obtain a water rights permit and certificate are as follows:

- Submission of application and fees
- DOE review and public notice publication
- Agency conclusions sent to applicant
- Applicant's submittal of filing fee and construction permit is issued
- Upon construction completion, applicant is issued water right certificate

The water rights process may be the most time-consuming of all the permits due to the lengthy review of each application. However, if early consultation is established and adequate information is provided to the DOE, the water rights should be established without difficulty.

ARMY CORPS OF ENGINEERS

SECTION 404 PERMIT

A Section 404 Permit must be secured from the U.S. Army Corps of Engineers for structures and work in or affecting navigable waters of the U.S., or for discharge of dredged or fill material into waters of the U.S. Most of the fishway construction is exempt from Section 404, however, certain activities require that a 404 Permit be obtained. These activities include building the left bank ladder at Dryden which is considered "new" construction, channel work and excavation upstream and downstream of both

fishways in order to improve the intake and exit hydraulics, and temporary cofferdams used for dewatering.

On the USCE's standard Section 404 form the applicant must give a detailed description of the proposed activity (i.e., construction methods, structural designs and materials, soils, and composition of dredge tailings or fill), complete information about the project location, and a status list of all other permits. Drawings must be submitted which show the location and layout of the proposed project. 'These drawings can be preliminary rather than final designs.

Once the application is submitted to the USCE, a Notice of Application is issued followed by a 30-day comment period. During this time, public comments are accepted by the USCE and a public hearing may be held if requested. The USCE also circulates the application to local, state and federal agencies. This task requires less time if other permits have been approved. If there are n3 objection: to the construction activity, a permit can usually be issued within 90 days at a cost of $10.

U.S. FOREST SERVICE

SPECIAL USE PERMIT

A Special Use Permit would be required if lands owned by U.S. Forest Service (USFS) are used during construction of fish ladders. This may be necessary for construction at Tumwater Falls. Temporary fish passage during construction at the right bank of Tumwater Falls Dam may require staging minor construction on USFS land. At this time, however, activities are planned only o land owned by Chelan County PUD. Figure 2 is a land ownership map for the Tumwater Falls area.

Should a Special Use Permit be necessary, the USFS prefers that the contractor apply for the permit rather than BPA. The permit holder is directly responsible for the use and treatment of USFS lands. The Tumwater Falls work may only require a letter of aughrorization. Review and approval of construction plans and schedules will require approximately two weeks if adequate information is supplied to the USFS. There is no cost to the applicant. There are no time limits as to start-up or duration of construction. The only condition requires that the contractor comply with the uses and terms agreed upon prior to issuing the permit.

WASHINGTON DEPARTMENT OF TRANSPORTATION

As mentioned in the previous section, the Washington Department of Transportation possesses a right-of-way along the left bank of the Wenatchee River at Tumwater Falls. The Tumwater Falls project will involve using a portion of this land during construction for stationing equipment and supplies. As such, a General Use Permit must be secured from the DOT.

To initiate the process, a letter should be submitted to the DOT describing the project and the type of temporary access needed. The DOT will then send a guide form describing the information required of the applicant. This usually includes the area needed for the project, location, duration of construction, and purpose of land use. After approximately one month's review, the permit is issued without charge. Should the construction schedule be extended past initial plans, extensions to the General Use Permit can be obtained.

OTHER PERMITS AND EASEMENTS

The area surrounding Dryden Dam, excluding the dam itself and a one acre lot in the middle of the river, is owned by private

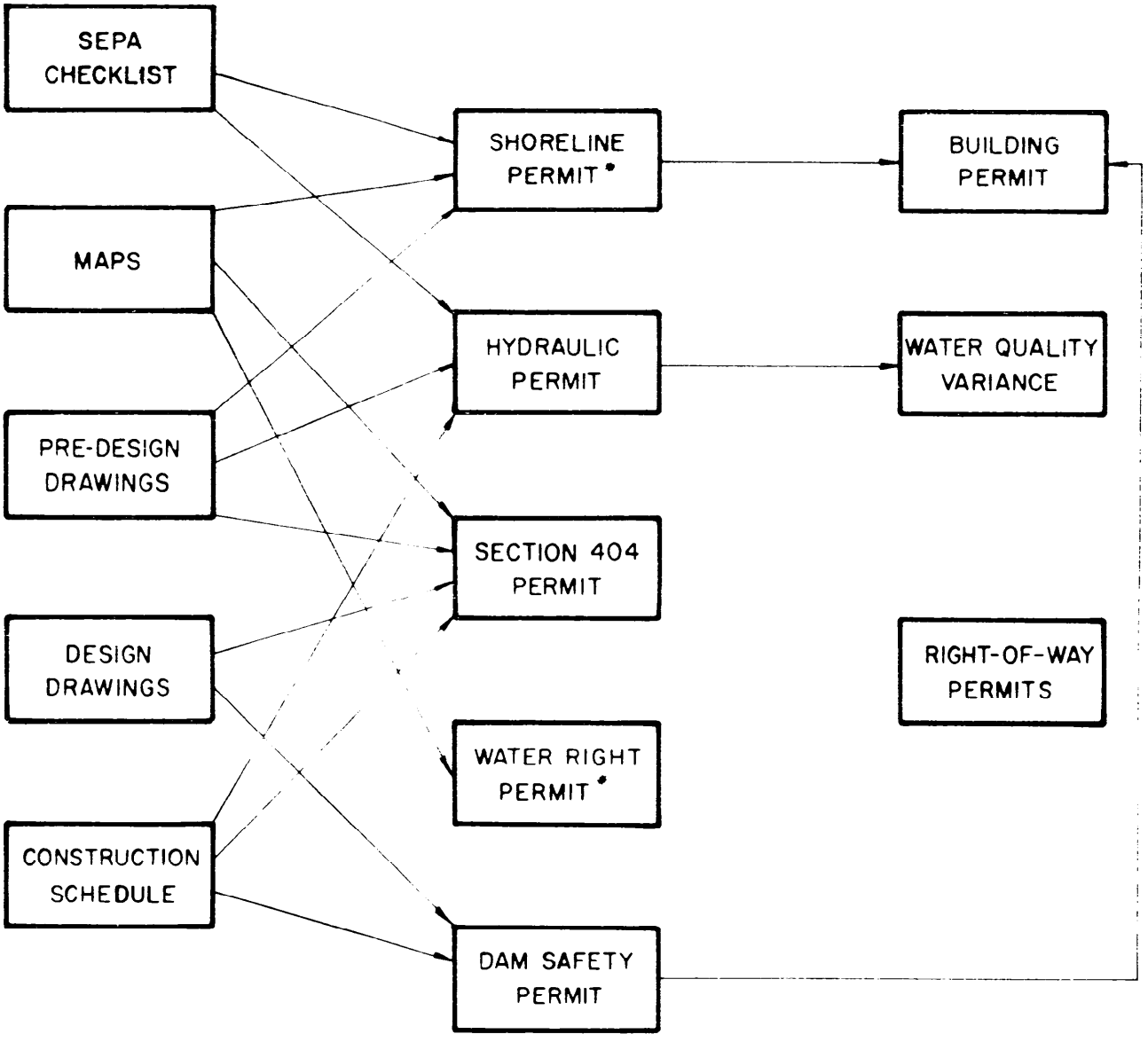
landholders. Although there are roads leading to the right and left dam abutments, they are on private property and temporary easements must be granted if they will be used during construction. The road to the left abutment also crosses the Burlington Northern Railroad right-of-way. Land ownership at the Dryden site is shown in Figure 3.

Presently, Chelan County PUD has prescriptive rights to access Dryden Dam for maintenance by the two roads mentioned above. This means that Chelan County PUD has the right to access the dam since the structure has existed for over seven years and is enclosed by other property owners. Approval for construction access must be secured in one of two ways; either BPA can become attached to Chelan County PUD's prescriptive rights by legal transfer, or BPA must receive temporary easements from the appropriate landowners.

Additionally, formal authorizations will be required from Chelan County PUD since they own both Tumwater Falls and Dryden dams. Close contact has been maintained with Chelan County PUD concerning the projects and this authorization should be easily obtained.

APPENDIX A

FIGURES



*INDICATES PERMITS WHICH POTENTIALLY INVOLVE LONG TIME PERIODS

FIGURE 1

TUMWATER FALLS AND DRYDEN DAM
FISH PASSAGE PROJECT

SEQUENCE DIAGRAM FOR PERMITS

DATE: MAY 1984

JOB NUMBER: S1019.01

OTT

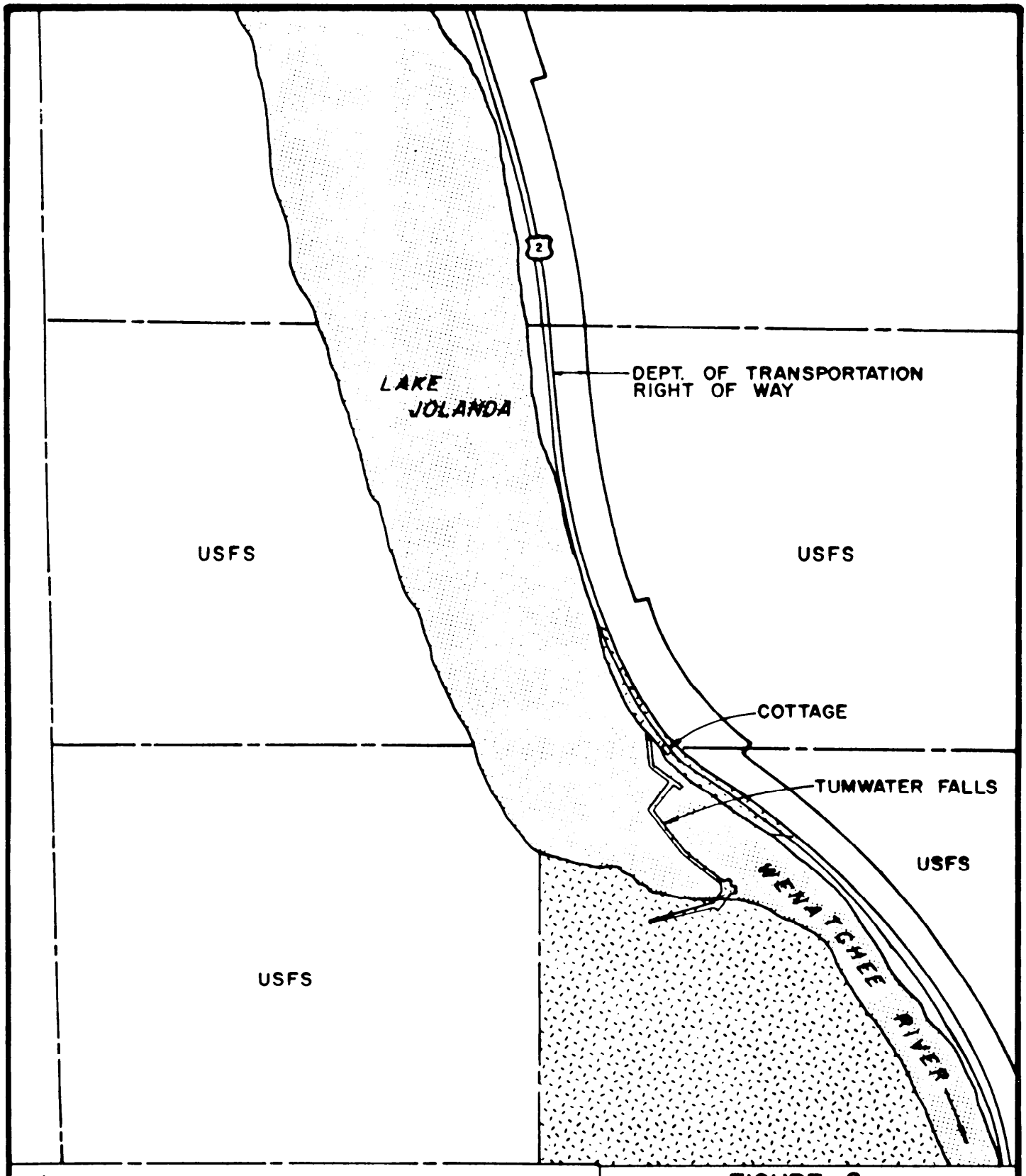


FIGURE 2

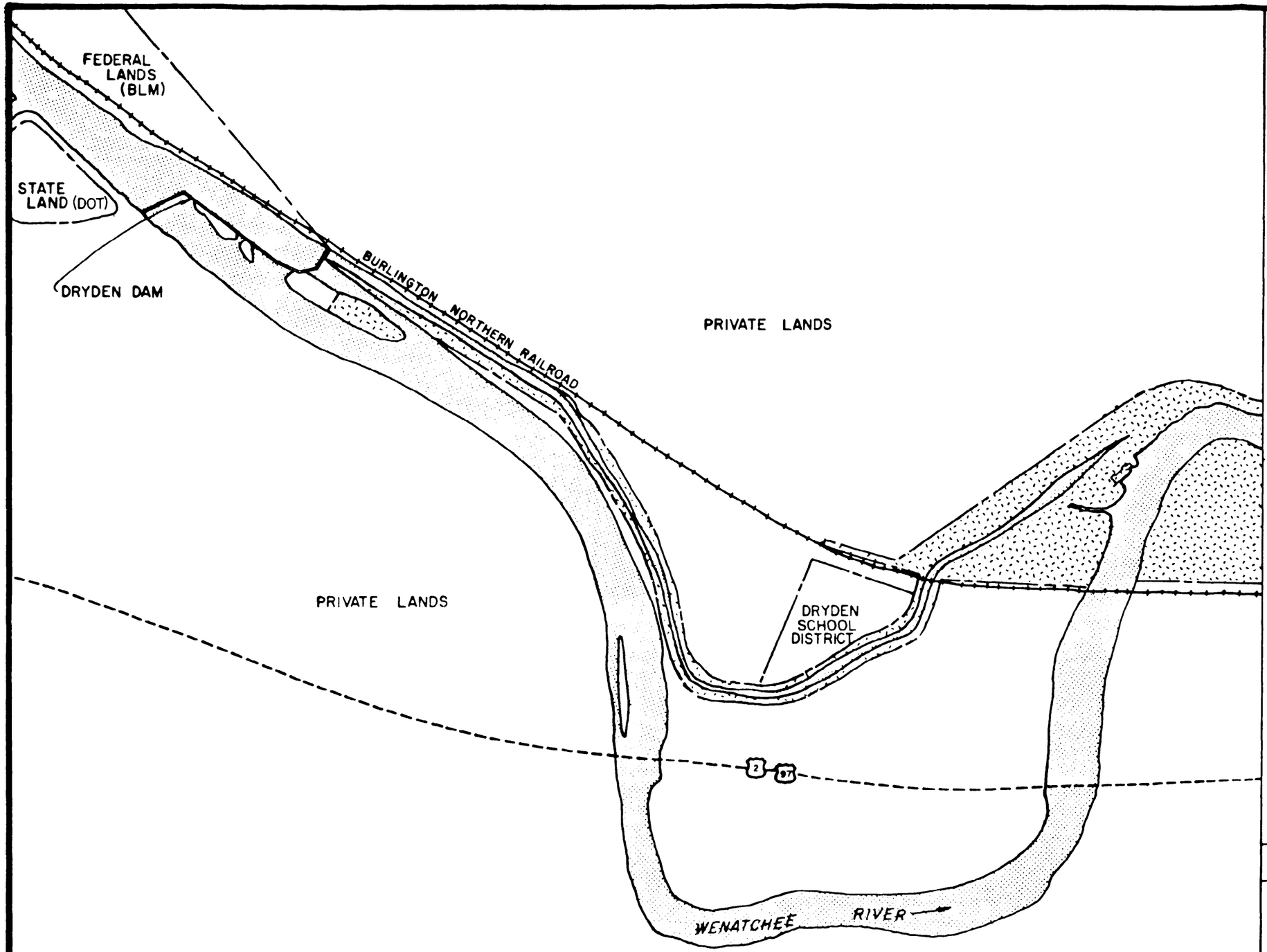
TUMWATER FALLS AND DRYDEN DAM
FISH PASSAGE PROJECT

TUMWATER FALLS
LAND OWNERSHIP MAP

DATE: MAY 1984

JOB NUMBER: S1019.01

OTT



LAND OWNERSHIP BOUNDARIES

CHELAN COUNTY PUD

SOURCE: CHELAN COUNTY PUD 1980

400 200 0 400 800 Feet

FIGURE 3

TUMWATER FALLS AND DRYDEN DAM
FISH PASSAGE PROJECT

DRYDEN DAM
LAND OWNERSHIP MAP

DATE: MAY 1984

PROJECT NUMBER: S1019.01

OTT